WILLATS'S SCIENTIFIC MANUALS, No. 1.

PART II.

PLAIN DIRECTIONS

FOR OBTAINING

PHOTOGRAPHIC PICTURES

UPON

WAXED AND ALBUMENISED PAPER

AND

Glass,

BY

COLLODION AND ALBUMEN,

Including a Third Edition of LE GRAY'S TREATISE *on* PHOTOGRAPHY; *a description of the* STEREOSCOPE *and the manner of taking pictures suited for it; also, the process for Copying* MICROSCOPIC OBJECTS, *&c.*

EDITED

BY CHARLES HEISCH, F.C.S.,

Lecturer on Chemistry at the Middlesex Hospital.

London:

Richard Willats,

(LATE T. & R. WILLATS,)

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Price Two Shillings, or by Post 2*s.* 6*d.*

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INTRODUCTION.

THE Calotype Process of Mr. TALBOT, has been so often and minutely described, that it is not my intention to allude to it in the present work, further than to remark that on it are based almost all the subsequent processes which have been published. Though experiments have been made with all substances sensitive to the action of light, nothing has yet been found to supersede the iodide of silver originally recommended.

All amateurs of Photography must be aware that success in the practice of the Calotype much depends on the manipulatory skill of the operator, and on the observance of various little precautions which it is almost impossible to describe. Few of those who attempt to follow the printed directions, without having seen the various operations performed by a practised hand, arrive at satisfactory results, until after repeated failures; and this not so much from any deficiency in the explanations, as from the difficulty of describing all the little niceities of manipulation, which should be seen to be understood.

I have endeavoured in the following pages to detail only those processes which from their intrinsic simplicity are more capable of being perfectly described. The abandonment by Mr. TALBOT of his patent right, has given a great impulse to Photography in this country, and it is

to be hoped that the assertion so often made, that the progress of the art here has not been so great as on the continent, will soon cease to be repeated; indeed the late exhibition at the Society of Arts shewed, that though labouring under disadvantages of atmosphere with which their foreign brethren had not to contend, the English photographers were not so far behind as had been imagined. I cannot but congratulate photographers also on the establishment of a society for the furtherance of the art, headed by artists of such high standing as the Earl Somer's, Sir C. Eastlake, and Sir W. Newton. This must at once silence those who wish to degrade photography to a mere mechanical art, instead of admitting the great benefit which, if properly used, it can confer upon high art. To the numerous friends to whom I am indebted for many valuable hints, I offer my very best thanks for their assistance, and particularly to Mr. Henneman, of whose kindness, and readiness to impart information, it is impossible to speak too highly. In conclusion, I venture to express a hope, that as one of the objects of the Photographic Society is the free communication of all discoveries in the art, the days of patents and secrets in photography may be said to have passed away.

PHOTOGRAPHY ON PAPER.

M. LE GRAY'S PROCESS.

M. Le Gray having been the first to propose the use of paper waxed previously to being subjected to any other preparation, and which can be dried, and preserved for some time without deterioration after being rendered sensitive, I shall first describe the method of preparing it precisely as detailed by him in his late work "Photographie, Traité Nouveau Théorique et Pratique des Procédés et Manipulations," published in September 1852, and shall afterwards describe the modifications which the process has undergone in the hands of other operators. After stating that the choice of paper to be waxed before iodizing is less important than of that which is to be used unwaxed, and that he prefers the thin paper of Messrs. Canson Frères to all others, rejecting only those sheets in the thickness of which there are any considerable inequalities, or which are stained with iron,* M. Le Gray proceeds to describe as follows, the

PRELIMINARY PREPARATION OF THE NEGATIVE PAPER.

The object of this preparation is to fill all the pores of the paper with white wax, which causes it to be more equally acted on by the subsequent preparations. Paper thus prepared assumes the appearance and firmness of parchment, and has the advantage of not requiring to be waxed after the picture is developed, before taking the positive proof.

* Even these stains may be to a great extent removed by the use of free iodine as hereafter recommended.

Take a large daguerreotype plate, place it on a levelling stand quite horizontal, heat it by passing a spirit lamp backwards and forwards under it, or (which is better) place it on a hot water bath; when warm, rub a piece of white wax on its surface.

When you have a good coating of melted wax on the plate, lay a sheet of paper upon it, and bring it into perfect contact with the wax, by passing a card gently over the back. When the paper has imbibed the wax equally all over, place it between several folds of fine white blotting paper, and pass over it an iron heated until a little saliva dropped upon it boils, but does not roll off. If the iron be hotter it spoils the wax and stains the paper.

A sheet of paper thus prepared should be perfectly transparent, and have no shining places on its surface, as the blotting paper should absorb all the wax which has not completely penetrated the texture of the paper.*

FIRST OPERATION.

IODIZING THE PAPER.

† A. Take rice 200 grammes, isinglass in leaves 20 grammes, distilled water 3 litres. Let them simmer in an earthen vessel till the rice is quite soft, but the grains still unbroken. The liquid will then contain the glutinous matter of the rice, without being rendered thick by the starch. Filter the liquid through fine linen. This liquid gives great body to the paper, and much intensity to the blacks of the picture.

B. In one litre of this rice water, dissolve of

Sugar of Milk	45	grammes	0	centigrammes.
Iodide of Potassium ..	15	,,	0	,,
Cyanide of Potassium	0	,,	80	,,
Fluoride of Potassium	0	,,	50	,,

* I have found it better to plunge the sheets of paper completely into melted wax in a shallow dish, and when well soaked to hang them, previously to ironing them, before the fire, or in a hot air chamber, as long as any wax drops from them. By this means a good deal of wax is saved, and much less left for the blotting paper to absorb.

Should you use a tin dish, which is not so good as a porcelain one, be careful to have it thickly and perfectly tinned, for if there be the least flaw in the tin, the wax becomes very speedily contaminated with iron, and completely spoils all your paper.

† These Letters refer to Notes, pages 27 and 28.

When the salts are dissolved, filter through fine linen, and preserve in a well stoppered bottle. This solution will keep a long time, and may be used to the last drop. In cold weather it should be slightly warmed before putting in the paper. To prepare the paper, pour some of the solution into a flat dish, and plunge the waxed paper sheet by sheet completely into it, taking care to remove all air bubbles. The depth of solution in the dish should be at least four or five centimétres,* as by having abundance of liquid the paper is more perfectly iodized. Put 15 or 20 sheets at once in the solution, and leave them from half an hour to an hour, according to the thickness of the paper, thick paper taking a longer time than thin. When uniformly soaked, turn over the pile, and beginning with the sheet first immersed, hang them up by one corner to dry, placing a small piece of blotting paper on the opposite corner to facilitate the fall of the drops. Never put English and French paper in the same solution, as the English paper contains free acid, which liberates iodine and colours the French paper deep violet.†

When the sheets are dry, cut them to the size of your camera frames, and preserve them in a portfolio. This paper is called for brevity's sake, iodized paper. Paper thus prepared should be of a light violet colour, which makes the after preparation easier. This colour is easily obtained when the iodizing solution is old, because it becomes acid by keeping, which liberates a part of the iodine.

The same effect is produced with a new solution, by adding to every litre 25 centigrammes of iodine.‡

The paper may be prepared thus far by day light, but should not be exposed too long, as though not very sensitive, a long exposure to a bright light decomposes the iodide of potassium, and forms an iodide of starch on the paper.§

The liquid which remains after the paper is withdrawn, is to be preserved in a well stoppered bottle; it only requires to be filtered immediately before it is again used.

* About 1½ inch.

† I have not found this of any consequence; indeed, I do not see how this statement is to be reconciled with the subsequent paragraph, in which the use of free iodine is recommended, and certainly such good results cannot be obtained without it.

‡ 2 grains to 1 pint of solution.

§ I have not found this to be the case.

SECOND OPERATION.

C GIVING SENSIBILITY TO THE PAPER.

Take of Nitrate of Silver	.	20 grammes
Glacial Acetic Acid	.	24 do.
Pure Animal Charcoal	.	8 do.
Distilled Water	.	300 do.

Dissolve the Nitrate of Silver in the water, in a stoppered bottle; then add the Acetic Acid and the Animal Charcoal.

Shake the bottle, and allow it to stand for half an hour, when the Charcoal will have subsided, and the liquid will be fit for use.

This solution must be made by candle light,* and preserved in a bottle covered with a black case. The above quantity of solution is sufficient to give sensibility to 20 sheets of paper, 35 centim. long, by 25 centim. broad;† each sheet of this size containing enough iodide of potassium to decompose 1 gramme of nitrate of silver.

The liquid, after having been used, should be again poured on the animal charcoal, which decolorizes it, and renders it perfectly limpid.

The little needle-shaped crystals which form on the bottom of the bottle, serve to supply silver to a partially exhausted solution.

When you wish to prepare the paper, filter as much of the solution as you want for use; then take two perfectly clean dishes, in the first pour the filtered solution to the depth of 1 or 2 centims‡, and fill the second with distilled water.

Take a sheet of iodized paper, and lay it with one side on the surface of the solution of aceto-nitrate of silver, taking care to remove all air bubbles; then with a hog's bristle brush, press the sheet completely under the solution, and remove all air bubbles from its upper surface with the brush. *The hairs of this brush must not be fastened with metal.*

Leave the paper in the solution for four or five minutes, or if it be of

* It is far more convenient to cover a window with two folds of common yellow calico, which stops all the chemical, whilst it admits nearly all the luminous rays.

† 13½in by 10in.

‡ From ¼in. to ⅜ inch.

the violet color before mentioned (which is better), until it becomes white.

Withdraw the sheet from the solution, and plunge it completely into the distilled water, removing the air bubbles with another brush which must be kept exclusively for the purpose.*

Prepare in this manner ten sheets of paper, and place them one on the other in the distilled water.

Pour off the water into a bottle, holding the sheets on the bottom of the dish with the brush. Cover them with fresh distilled water, which pour into the same bottle. If you wish to preserve the paper a long time before using, you must wash it a third time.

This paper must not be dried by suspending it in the air, as it then becomes black all over on being immersed in the solution of gallic acid. It must be dried with perfectly new and clean blotting paper, and preserved for use between sheets of the same paper, placing first a sheet of prepared paper, and then a sheet of blotting paper, so as to keep the sheets of the prepared paper separate.†

The paper thus prepared preserves its sensibility for a fortnight, or even a month if it be well kept from the light; it is therefore very valuable to travellers, who need only carry with them a portfolio with two divisions, one for the prepared paper, the other for the pictures which they take. The image need not be developed for two or three days.

Having prepared ten sheets of paper, return the solution to the bottle containing the animal charcoal, shake it up, allow it to settle, and again filter it before preparing the remaining ten sheets of paper, for which the solution will serve. When the solution is thus exhausted, precipitate the little remaining silver by pouring into it a solution of chloride of sodium (common salt.) Wash the precipitated chloride of silver with distilled water, and use it to add to the hyposulphite of soda for fixing the positive proof as hereafter directed.

Whatman's paper unwaxed may be prepared in the same manner as the foregoing, and answers very well, but will not keep so long as the

* I have found a glass rod bent into the form of a triangle as recommended by Dr. Percy much better than any brush.

† I do not find this necessary. I simply hang the paper up to dry in a dark room, and when dry put it into a portfolio.

waxed paper. When unwaxed paper is used, it is better to add to each litre of the iodizing solution the whites of two eggs beaten into a froth.

THIRD OPERATION.

EXPOSURE IN THE CAMERA.

Take especial care that the principal object in the picture is perfectly in focus on the ground glass. This can frequently only be accomplished by a sacrifice of the secondary parts of the picture. In a landscape it is in general better to focus on the part intermediate between the fore and back ground.

This part of the operation requires much judgment, and it is only the artist, or person of good taste who can decide properly which part of a view to sacrifice, and which part to bring out strongly. The time of day at which to take a view, so as to have the light in such a position as to produce the best effect, is also a matter entirely dependent on the judgment of the operator, and for which no directions can be given.

The time during which the paper should be exposed in the Camera, can only be determined by experience, but on a proper regulation of this time depends in a great measure the beauty of the picture.*

For a portrait, with a double combination lens capable of filling the whole plate, (8½in. by 6½in.) from thirty seconds to one minute in the shade, and from ten to thirty seconds in the sun, are generally sufficient.

For landscapes, with a single lens, and a diaphragm of fifteen or twenty millimètres diameter, the time of exposure should vary according to the color of the objects, from thirty seconds to twenty minutes. Thus, with an equal amount of light, a stone building would require an exposure of thirty seconds, while a picture of forest trees could not be produced in less than twenty minutes.

Heat, which much accelerates this part of the process when operating by the humid method, has little or no effect when dry paper is employed.

* In another part of his work M. Le Gray says that you should impress on your mind the fact that however short the exposure in the Camera may have been, you can always get a good picture by leaving the proof a longer time in the gallic acid; and by way of example states that he took two pictures of the same object at the same time, exposing one for twenty seconds, and the other for fifteen minutes, and that both turned out equally good; but the first required twenty-four hours in the gallic acid, and the last only one. I have certainly never been able to obtain such results.

After exposure in the camera, the image is scarcely visible, and is only developed by the subsequent operation which may be deferred for as much as a fortnight without risk of failure.

FOURTH OPERATION.

DEVELOPMENT OF THE IMAGE

Solution of gallic acid is the agent employed to develop the image.

The solution should never be made till it is wanted, as an old solution damages the white parts of the picture. It is therefore convenient to weigh out a number of small parcels of gallic acid, each containing 0·50 centi-grammes.* When the solution is wanted, dissolve the contents of one of these parcels in ¼ of a litre of the water in which the wax paper has been washed, and which contains precisely the quantity of aceto-nitrate of silver necessary to give a good proof. When the gallic acid is dissolved, plunge the proof into the solution, taking care that it is completely covered and that there are no air bubbles. For this purpose it is necessary to use an abundance of solution, as the wax paper is not easily covered by a small quantity.

The solution here recommended contains quite sufficient acid completely to develop the image, and has this advantage over the saturated solution formerly used, that it never deposits crystals in the body of the paper, which the other is apt to do owing to the water evaporating while the proof is in the solution.

Watch the development of the image closely, and as soon as it is very vigorous, remove the proof from the solution and wash it in several waters, rubbing it gently with the finger to remove any deposit that may have taken place upon it.

The grey tint which the paper assumes in the gallic acid is of no consequence, as it entirely disappears when the proof is examined by transmitted light.

From the tint assumed by the proof in the gallic acid, you can judge if the paper have been exposed for the right length of time in the camera.

* This must mean 50 centigrammes, or 8grs. to 9 oz. of the wash water.

If when examined by transmitted light, it appear of a greyish black all over, or if the high lights (which ought to be of a dense black in the negative) are no darker than the half tints, it is a sign that the proof has been too long exposed.

If on the contrary, the high lights only become visible, and the image soon ceases to become any more forcible, the proof has been exposed for too short a time.

The time occupied in developing the image may be much shortened by warming the solution of gallic acid. To do this, it is best to place the dish containing the proof on a water bath heated to between 30° and 40° cent.* by means of a lamp.

If any oxide of silver deposit on the proof, it may be removed by pouring on it some pure acetic acid, and rubbing it gently with a brush.

FIFTH OPERATION.

FIXING THE NEGATIVE.

Dissolve 100 grammes of hyposulphite of soda in 800 grammes of water.† Pour this solution into a dish to the depth of 0·5 centimetre,‡ and plunge the proof completely into it, taking care to remove all air bubbles.

Never put more than one proof at a time into this bath.

The hyposulphite dissolves all the salts of silver which are unacted upon by the light, but has no effect on the gallate of silver which forms the blacks of the picture. It requires from ten minutes to three quarters of an hour to effect this solution. It is known to be complete when all trace of yellow has disappeared from the paper, and when the white parts of the proof examined by transmitted light are perfectly clear and transparent. The paper should not be left in the bath longer than is absolutely necessary, as a too prolonged action of the hyposulphite enfeebles the blacks of the picture.

As soon as all the yellow iodide of silver is dissolved, remove the

* Between 86° and 104° Fahrenheit.

† Hyposulphite of soda 1oz., water 8oz.

‡ About 0·2 in.

proof from the bath, wash it in several waters, and allow it to float in a large basin of water for at least half an hour, to wash out all the hyposulphite of soda, and then dry it between sheets of blotting paper.

The solution of hyposulphite of soda may after filtration be used for fixing many other proofs. To restore the transparency which the proof has lost by the action of the various solutions, it is only necessary to warm it sufficiently to melt the wax which it contains. This may be done, either by holding it to the fire, or by placing it between one or two folds of paper and passing over it a warm iron. It is then ready for use, and positives may be obtained from it as hereafter directed.

The modifications which the foregoing process has undergone consist principally in various alterations in the iodizing solution.

The preparation of the rice water being a troublesome operation, every one was anxious to avoid it if possible.

Le Vicomte Vigier was the first to point out that whey properly clarified answered all the purpose of rice water, sugar of milk, &c.: he gives the following directions. To a quart of whey add the whites of two eggs beaten into a froth; when well mixed, heat nearly to the boiling point. The heat coagulates the albumen and clears the whey. Strain the liquid first though a sieve and then through paper.

In a quart of whey thus prepared, dissolve of

* Iodide of Potassium	400	grains.
Bromide of Potassium	50	,,
Cyanide of Potassium	30	,,
Fluoride of Potassium.....	23	,,

The paper is soaked in this solution, and afterwards treated in every respect according to M. Le Gray's directions.

The addition of bromide of potassium to the iodizing solution is a great improvement, as it not only increases the sensibility of the paper, but renders the whites of the picture much more pure and transparent.

THE next modification of the wax paper process which I shall mention is that of Mr. J. How. His directions are in all respects so good, that I

* These are as nearly as I can learn the original proportions which Le Vicomte Vigier employed, but as he never published them, I cannot speak quite positively. These proportions answer very well.

shall quote them almost entire, as they were published in Notes and Queries.—Page 93. No. 169.

"The easiest way of waxing the paper is to take an iron (those termed box irons are cleanest and best for the purpose) moderately hot in one hand, and pass it over the paper from side to side, following closely after it with a piece of white wax, held in the other hand, until the whole surface has been covered. By thus heating the paper, it readily imbibes the wax, and becomes rapidly saturated with it. The first sheet being finished, I place two more sheets upon it, and repeat the operation upon the top one, (the intermediate sheet serving to absorb any excess of wax that may remain) and so on until the number required is waxed. The sheets which now form a compact mass are separated by passing the iron over them; then placed between folds of bibulous paper, and submitted to a further application of heat by the means just described, to remove all superfluous wax and render them perfectly transparent."

To prepare the iodizing solution, "Take some milk quite fresh, and add to it drop by drop glacial acetic acid, in about the proportion of 1 to 1.5 fluid drachms to the quart, keeping the mixture well stirred with a glass rod all the time, which will separate the caseine; then boil in a porcelain vessel to throw down any caseine not previously coagulated, and also to drive off as much as possible of the superfluous acid. After boiling five or ten minutes, the liquor should be allowed to cool, and then be strained through a hair seive or a piece of muslin: when quite cold the chemicals are to be added.—They are the following:

Iodide of Potassium	385 grains
Bromide of Potassium	60 ,,
Cyanide of Potassium	30 ,,
Fluoride of Potassium	20 ,,
Chloride of Sodium in Crystals	10 ,,
Resublimed Iodine.....	1½ ,,

The above are dissolved in 35 fluid ozs. of the strained liquid, and after filtration through white blotting paper, the resulting fluid should be of a bright lemon colour. The iodizing solution is now ready for use, and may be preserved in well stopped bottles for any length of time." The remainder of Mr. How's process is precisely similar to M. Le Gray's, and need not therefore be repeated.

The method of waxing the paper here described is very superior to the original method of M. Le Gray, as it is applicable to any sized sheet of paper, consumes much less wax, and leaves so small a quantity for the blotting paper to absorb, that very little comparatively is employed.

I have long been of opinion that in making the iodizing solution, too little attention has been given to the combining proportions of the various salts, and that better results could be obtained if more definite proportions were employed. I therefore instituted a series of comparative experiments between papers made according to the foregoing directions, and some which I prepared in which the salts employed were in atomic proportion, the result of which fully confirmed my expectation. I first satisfied myself that the three essential salts in the solution were an iodide, a bromide, and a chloride, and that the others might be omitted without affecting either the sensibility of the paper, or the beauty of the tints obtained. The proportions which I find answer the best are 4 atoms of iodide, 2 of bromide, and 1 of chloride. I make use of whey prepared according to Mr. How's directions as a solvent. If the milk be good this answers very well, but if poor, the addition of some sugar of milk to the whey is an improvement. I usually employ the following solution :—

Whey	1 quart Impl.
Sugar of Milk.....	100 grains,
Iodide of Potassium ..	400 grains.
Bromide of Potassium .	142 grains.
Chloride of Ammonium	33 grains, or Chloride of Sodium 36 grs.

Unless I suspect metallic spots in the paper, I use neither cyanide of potassium nor free iodine. The small quantity of acetic acid left in the whey liberates sufficient iodine to give a light violet colour to the paper, which serves as a guide for the time of exposure to the sensitive solution. I prefer iodizing in vacuo as recommended by Mr. J. Stewart, and described at page 20. It gives a more equal coating to the paper and seems also to prevent spotting; the soaking is also effected in a much shorter time.

To render the paper sensitive, I employ the same solution as Le Gray, page 8, but applied to one side of the paper only; this is best done by carefully floating the sheet on the sensitive bath, taking care to

have no air bubbles under it. It is then washed by floating in the same manner on distilled water, and changing the water once or twice.

To develop, I use—

Saturated Solution of Gallic Acid.....	½ ounce.
Of the Sensitive Solution	½ drachm.
Distilled Water	½ drachm.

This is spread on a glass plate placed perfectly level, and the proof laid face downwards upon it. I prefer the saturated solution of gallic acid, and the addition of the somewhat large proportion of silver solution, as it causes the development to be much more rapid, and is not so liable to give a precipitate on the paper as those solutions in which the proof must remain for a comparatively long time.

The following process was published by Mr. Crookes, in Notes and Queries, No. 6. p. 443. After some preliminary observations he says:—

"My method is a modification of Le Gray's process, in which the pores of the paper are saturated with wax previous to the formation of the sensitive surface. This is undoubtedly the best, both as regards the brilliancy of the finished picture, and the ease and convenience of manipulation; but there are several circumstances which tend to impair the beauty of the results, foremost of which may be mentioned the spots, one or two being generally met with even on the best paper. By the following slight modification I have succeded in removing the impurities which cause the spots, and also diminishing the time of exposure in the camera."

After describing the waxing of the paper, Mr. Crookes thus proceeds:—

"The next operation consists in iodizing the paper; the bath is composed of

Iodide of Potassium	1 oz.
Water	1 pint imp.

with the addition of as much free iodine as will give it a sherry colour. This removes the iron and brass, of which the spots generally consist: it will require renewing now and then. The sheets are to be completely immersed in this bath, for at least two hours, taking care to avoid air bubbles, and then hung up to dry: they will be of a deep purple colour,

owing partly to the union of the iodine with the starch in the paper, and will keep good for any length of time.

"The solution for rendering these iodized sheets sensitive, consists of

Nitrate of Silver.....	15 grains
Glacial Acetic Acid.....	15 grains
Water	1 oz.

"The marked side of the paper is to be laid carefully on this solution, and kept there for about half a minute longer than is necessary to completely decolorize it, (from seven to ten minutes) and then floated in distilled water for a few minutes. It must then be dried between blotting paper, and kept in perfect darkness in a portfolio until required; with one washing it will not keep good longer than six days, but if washed sufficiently, it will keep good for weeks."

"For developing the picture, I employ four parts of a nearly saturated solution of gallic acid, and one part of the solution previously employed for exciting the paper; these are to be well mixed, and the marked side of the paper floated on it. The picture will soon begin to appear, and should be completely out in less than an hour, and before the gallo-nitrate is decomposed; it must then be washed, soaked in tolerably strong hyposulphite of soda until all the yellow iodide is removed, washed again several times and then dried, and either ironed over, or held before the fire to melt the wax. The greatest care must be taken to have the dish to contain the gallo-nitrate perfectly clean; it ought to be rubbed with strong nitric acid every now and then, to remove the stains from a previous operation; unless this precaution be taken to avoid the presence of dirt, the picture will be covered with stains, similar to marbling in bookbinding. The gallic acid and nitrate of silver must also be filtered before mixing."

I should be inclined to think from some expressions in this communication, that Mr. Crookes had never fairly tried Le Gray's process; had he done so, he would not have spoken of spots occurring on paper prepared by that method. The cyanide of potassium, and free iodine, recommended by Le Gray, remove metallic spots at least as effectually as the free iodine in Mr. Crookes' process. I cannot agree with Mr. Crookes in considering that his paper is more sensitive than Le Gray's; indeed, I have found quite the reverse to be the case. The very deep

colour given to the paper, is a disadvantage in this process, as it necessitates a much longer exposure to the sensitive solution, than when only of the light violet colour originally recommended. The saving of all the trouble of making rice water or whey, seems at first sight a great point gained, but a comparison of the results will, I think, shew that it is after all, trouble well bestowed; the depth of the black, and perfection of the middle tints, more particularly in views comprehending objects at very different distances, being so much greater when the original solution is employed. I have never been able, by this process, to obtain first rate results, excepting where little variety of light and shade are to be represented.

NEGATIVES ON UNWAXED PAPER.

These papers are mostly used wet, and have not therefore the advantage of keeping for any time. Le Gray gives the following directions in the work already referred to:

The paper is iodized in precisely the same manner as the waxed paper, the iodizing solution being made in the same way, only with the addition of the whites of two eggs to each litre of solution.

To render the paper sensitive, pour some freshly filtered solution of acetonitrate of silver of the strength before recommended into a shallow porcelain dish, or on to a piece of plate glass placed quite horizontal; take a sheet of iodized paper by two corners and drop it with one side only on the acetonitrate, raise and lower it several times so as to remove all air bubbles from the under surface. To avoid soiling the fingers, use either an ivory spatula to place under the corner of the paper, between which and the finger the sheet is to be supported, or else take hold of the corners with two pair of forceps made of horn or bone. Be careful to prevent any of the solution of aceto-nitrate from getting on the back of the paper, as it causes inequalities in the sensibility, and consequently stains on the picture. Let the paper remain on the solution until the sensitive coating is completely formed, which will take from one to five minutes, according to the temperature and the quality of the paper—English paper taking more time than French. Place the paper thus prepared quite wet upon a slate on which you have previously laid a sheet of blotting paper soaked in water. Slate is preferable to all other

materials for this purpose, as it preserves the moisture longer; the paper placed under the sensitive sheet should be very clean and free from all stains of iron. Always keep the slate inclined towards that edge which is to be lowest in the camera. If this precaution be neglected, the liquid which collects at the lower edge will run back over the surface of the paper and produce stains. Paper thus stretched upon a slate will remain for three or four hours without becoming detatched. If the paper is to be kept longer before it is exposed in the camera, soak the under sheet in a weak solution of gum arabic, which retains the moisture longer and is more sticky. If it be preferred, the moist paper may be placed between two flat glasses in the camera.* Great care must be taken to have these glasses perfectly clean and free from scratches. For cleaning both these glasses and the dishes, there is nothing so good as Papier Joseph; it is very superior to linen, as it absorbs both the moisture and impurities much more perfectly. It should not be spared, as it is better to use a sheet too much than to be uncertain of the cleanness of your apparatus.

When the under sheet of paper adheres well to the slate it should not be changed for every proof, but simply be wetted with some fresh water before applying a new sheet of sensitive paper. The remainder of the process is precisely similar to that with wax paper.

The following letter to Sir J. Herschel, which appeared in the "Athenæum," No. 1311, p. 1363, will be read with interest by all amateurs of Photography, as giving the results of an experiment new to the art.

"Pau Pyrenees.

"My dear Herschel,—Thanks to the valuable indications of Prof. Regnault, of the *Institute*, I have been enabled to produce, what appear to me, most satisfactory results in *Photographic Landscapes on Paper*. In this remote corner (so deficient in resources for experiment) I feel that I am but very partially acquainted with the results obtained and the progress making in the great centres, Paris and London; but I think

* When two glasses are made use of, the paper must be pressed between blotting paper before being placed between them. If it be put in quite wet, the moisture is spread unequally over the surface and causes irregularities in the sensibility of the paper.

that, in detailing the simple process and manipulation I now adopt, indications of some value, and suggestive of further improvement to fellow-labourers in the art may be found; and if you are of the same opinion, you will perhaps facilitate the communication of these details to our photographers at home.

"The following observations are confined to negative paper processes, divisible into two—the *wet* and the *dry*. The solutions I employ for both these processes are identical, and are as follows:—

"Solution of Iodide of Potassium, of the strength of 5 parts of iodide to 100 pure water.

"Solution of Aceto-Nitrate of Silver, in the following proportions: 15 parts of nitrate of silver; 20 of glacial acetic acid; 150 of distilled water.

"Solution of Gallic Acid, for developing, a saturated solution.

"Solution of Hyposulphite of Soda; of the strength of 1 part hypo. of soda to from 6 to 8 parts of water.

"The solutions employed are thus reduced to their simplest possible expression, for it will be observed that in iodizing I employ reither rice-water, sugar of milk, fluoride, cyanide, nor free iodine, &c.; but a simple solution of iodide of potassium (the *strength* of this solution is a question of considerable importance, not yet, I think, sufficiently investigated).

"For both the wet and the dry processes I iodize my paper as follows:—In a tray containing the above solution I plunge, one by one, as many sheets of paper (twenty, thirty, fifty, &c.) as are likely to be required for some time. This is done in two or three minutes. I then roll up loosely the whole bundle of sheets, while in the bath; and picking up the roll by the ends, drop it into a cylindrical glass vessel with a foot to it, and pour the solution therein, enough to cover the roll completely (in case it should float up above the surface of the solution, a little piece of glass may be pushed down to rest across the roll of paper and prevent its rising). The vessel with the roll of paper is placed under the receiver of an air-pump and the air exhausted; this is accomplished in a very few minutes, and the paper may then be left five or six minutes in the vacuum. Should the glass be too high, (the paper being in large sheets) to be inserted under a pneumatic pump receiver, a stiff lid lined with India-rubber, with a valve in the centre communicating by a tube with a

common direct-action air-pump may be employed with equal success. After the paper is thus soaked *in vacuo* it is removed, and the roll dropped back into the tray with the solution, and then sheet by sheet picked off and hung up to dry, when, as with all other iodized paper, it will keep for an indefinite time.

"I cannot say that I fully understand the rationale of the action of the air-pump,* but several valuable advantages are obtained by its use: —1st. The paper is thoroughly iodized, and with an *equality* throughout that no amount of soaking procures, for no two sheets of paper are alike, or even one, perfect throughout in texture; and air bulbs are impossible. 2nd.—The operation is accomplished in a quarter of an hour, which generally employs one, two, or more hours. 3rd.—To this do I chiefly attribute the fact that my paper is never solarized even in the brightest sun; and that it will bear whatever amount of exposure is necessary for the deepest and most impenetrable shadows in the view, without injury to the bright lights.

"*Wet Process.*—To begin with the *wet* process. Having prepared the above solution of aceto-nitrate of silver, float a sheet of the iodized paper upon the surface of this sensitive bath, leaving it there for about ten minutes. During this interval, having placed the glass or slate of your slider quite level, dip a sheet of *thick* clean white printing (unsized) paper in water, and lay it on the glass or slate as a wet lining to receive the sensitive sheet. An expert manipulator may then, removing the sensitive sheet from the bath, extend it (sensitive side uppermost) on this wet paper lining, without allowing any air globules to intervene.—But it is difficult, and a very simple and most effectual mode of avoiding air globules, particularly in handling very large sheets, is as follows—Pour a thin layer of water (just sufficient not to flow over the sides) upon the lining paper, after you have extended it on your glass or slate, and then lay down your sensitive paper gently and by degrees, and floating as it were on this layer of water; and when extended, taking the glass and papers between the finger and thumb, by an upper corner, to prevent their slipping, tilt it gently to allow the interposed water to flow off by the bottom, which will leave the two sheets of paper adhering perfectly and closely, without the slightest chance of air-bubbles;—it may then

* The use of the air pump in soaking iodized paper, was first proposed by Mr. R. Murray some years ago, but the experiments were never carried out.

be left for a minute or two, standing upright in the same position, to allow every drop of water to escape; so that when laid flat again or placed in the slider none may return back and stain the paper. Of course, the sensitive side of the sheet is thus left exposed to the uninterrupted action of the lens, no protecting plate of glass being interposed —and even in this dry and warm climate I find the humidity and the attendant sensitiveness fully preserved for a couple of hours.

"To develop views thus taken the ordinary saturated solution of gallic acid is employed, never requiring the addition of nitrate of silver; thus preserving the perfect purity and varied modulation of the tints. The fixing is accomplished as usual with hyposulphite of soda, and the negative finally waxed.

"*Dry Process.*—In preparing sheets for use when *dry* for travelling, &c., I have discarded the use of *previously waxed* paper,—thus getting rid of a troublesome operation,—and proceed as follows.—Taking a sheet of my iodized paper, in place of floating it (as for the wet process) on the sensitive bath, I plunge it fairly into the bath, where it is left to soak for five or six minutes—then removing it, wash it for about twenty minutes, in a bath, or even two, of distilled water to remove the excess of nitrate of silver, and then hang it up to dry (in lieu of drying it with blotting paper).—Paper thus prepared possesses a greater degree of sensitiveness than waxed paper, and preserves its sensitiveness, not so long as waxed paper, but sufficiently long for all practical purposes, say thirty hours, and even more. The English manufactured paper is far superior for this purpose to the French. To develop these views, a few drops of the solution of nitrate of silver are required in the gallic acid bath. They are then finally fixed and waxed as usual.

"These processes appear to me to be reduced to nearly as great a degree of simplicity as possible. I am never troubled with stains or spots, and there is a regularity and certainty in the results that are very satisfactory. You will have observed, too, how perfectly the aerial perspective and gradation of tints are preserved—as also how well the deepest shadows are penetrated and developed—speaking, in fact, as they do to the eye itself in nature. In exposing for landscape, I throw aside all consideration of the bright lights, and limit the time with reference entirely to the dark and feebly-lighted parts of the view; with a $3\frac{1}{4}$-inch lens, the time of exposure has thus varied from ten minutes

to an hour and a half, and the action appears to me never to have ceased.

"The influence of the air-pump in this appears to me very sensible, and deserving of further examination and extension. I purpose not only iodizing, but rendering the paper sensitive with the action of the air-pump, by perhaps suspending the sheet after immersion in the nitrate bath under the receiver of the air-pump for a few minutes, before exposure in the camera, or by some other manœuvre having the same object in view.

* "I should add, that I have chiefly employed Canson's French paper in iodizing with the aid of the pump. Few of the English manufactured papers are sufficiently tenacious in their sizing to resist the action of the pump, but they may easily be made so; and were, in short, the English paper, so far superior in quality to the French, only better sized, that it is with glue less easily soluble, even though more *impure*, there is scarcely any limit to the beauty of the views that might be produced.

"There are more minor details that might be given; but I fear repeating many a 'twice-told tale,' acquainted so little as I am with what is doing;—the preceding, however, may have some interest, and whatever is of value is entirely due to our friend M. Regnault, ever so generously ready as well as able to aid and encourage one's efforts.

"Ever yours, JOHN STEWART."

The pictures lately exhibited by Mr. Stewart, at the Society of Arts, fully bear out all that he says of them; the effects of distance, and the varieties of light and shade, being more beautifully preserved than in any photographs I have yet seen. How much of this perfection is due to the intrinsic merit of the process, how much to Mr. Stewart's skill as an operator, and how much to the light he enjoyed in the Pyrenees, are questions which it will require some time and many experiments to answer.

On one point, no one in England will be inclined to agree with him, viz:—That thirty hours is quite long enough for paper to keep. Even if fine weather could be reckoned on, all must allow, that the less

* Mr. Stewart's remarks respecting the Paper appear rather at variance, and it is difficult to say which he uses, French or English.

you have to carry, if going any distance, the better, and consequently that a portfolio of sensitive paper which will keep for six weeks, is better than one of simply iodized paper, together with a box full of bottles and dishes. But in this country, where though you prepare paper on a very fine night, you may have a week of wet or foggy weather succeeding it, paper which will only keep thirty hours, is no better, indeed not so good, as that which will keep but three or four, such as the wet paper before mentioned.

NEGATIVE ALBUMENIZED PAPER.

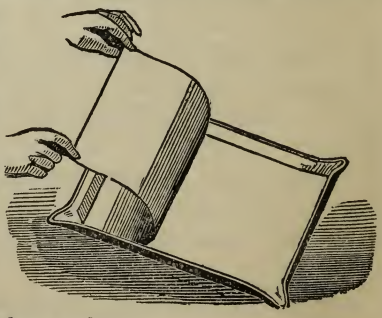
With the exception of the wax paper process, I know none which yields so good results as that on albumenized paper, the albumen preventing the texture of the paper from interfering with the perfection of the detail, as it undoubtedly does, when neither wax or albumen are employed.

Le Gray's directions for this process are the best I have yet met with. They are as follows:—

In the whites of ten eggs, dissolve—

D	Iodide of Potassium	4 grammes	cent.
	Bromide of Ammonium ..	0 ,,	50 ,,
	Chloride of Sodium	0 ,,	50 ,,

Beat the mixture in a porcelain basin with a wooden fork till it becomes a thick white froth. Let it stand for a night, and decant the clear liquid which has subsided. Pour this liquid into a flat dish placed perfectly horizontal, taking care to remove all froth. Take a sheet of paper by two corners, and place it with one side only on the solution, beginning with the edge opposite to that by which you hold it, and letting it fall at a right angle on the surface of the liquid so as to push out all air bubbles. The manner of doing this will be best understood by an inspection of the diagram No. 1.



The same manner of proceeding is to be adopted whenever paper is directed to be floated on a solution.

It is better to place a light before you, so that you may see all air bubbles through the paper.

Let the sheet remain on the solution for two or three minutes, then take it by one corner and remove it gently, but without stopping, and hang it up by the corner to dry.

Having prepared and dried as many sheets as you require, place them one on the other between two sheets of very smooth white paper, and pass over them a very hot iron, removing one sheet every time you pass the iron over them. This will render the albumen insoluble. The iron should be as hot as is possible without scorching the paper.

This paper is to be floated on the aceto-nitrate of silver precisely in the same manner as it was originally placed on the albumen. The solution of aceto-nitrate in this process should be made without the addition of animal charcoal, as that in which this body is employed seems to dissolve the albumen. The pictures are developed and fixed precisely in the same manner as those on waxed paper.

I think it is better to float the paper on the developing solution, than to plunge it in as here directed.

The following paper employed at the Royal Observatory, Greenwich, for the registration of meteorological observations, also gives very good results in the camera, but from the large quantity of bromide of potassium employed, it is more particularly adapted for use by artificial light. It may be used for taking positives by the light of a camphine lamp.

To a filtered solution of 4 grains of isinglass in 1 oz. of boiling distilled water, add 12 grs. of bromide and 8 grs. of iodide of potassium. The solution, either hot or cold, is applied to one side of the paper in such quantity as to wet it thoroughly but not to run off; the paper is then quickly dried at the fire, and may be preserved in a dry place. It is excited by solution of nitrate of silver, 50 grs. to the ounce of distilled water, and the image developed by a saturated solution of gallic acid to which a few drops of acetic acid have been added. It is subsequently washed and fixed in the usual way.

Proofs on unwaxed paper require to be waxed before good positives can be obtained from them. This operation is exactly the same as that of waxing paper already described, the mode detailed by Mr. How being by far the best.

It will be observed that in almost all these processes the strength of the sensitive solution is the same, however much that of the iodizing solution may vary. The reason of this is that the precise strength of this solution is quite immaterial, provided it contain enough silver to decompose all the salts contained in the paper, all excess being removed by washing. When the solution becomes so weak as no longer to effect this decomposition, it must be renewed, as any undecomposed iodide, or bromide of potassium, materially interferes with the action of the light on the silver salts.

In the Appendix to his last work, Le Gray gives the two following processes by which he says very beautiful results are obtained by a practised hand; but he cautions beginners against attempting them, as unless the operator be accustomed to the necessary manipulations, failure is pretty sure to follow.

NEGATIVE GELATINE PAPER.

E Dissolve 25 grammes of isinglass in a litre of distilled water, heating it on a water bath.

F

Take of	The above Solution, still hot	365	grammes.
	Iodide of Potassium	13	,,
	Bromide of Potassium	4	,,
	Chloride of Sodium	2	,,

When the salts are dissolved filter through fine linen. Pour the solution while hot into a dish, and plunge your paper sheet by sheet into it, taking care to remove all air bubbles. Let the paper remain for a quarter of an hour in the bath, and hang it up to dry.

The remainder of the process is precisely the same as that described at page 8 for giving sensibility, &c., to wax paper.

The iodizing solution may be kept and employed to the last drop; it only requires to be warmed and filtered immediately before it is again used. This process gives exceedingly delicate and harmonious proofs; it should be employed principally for subjects in which there are very strong contrasts of light and shade, as by it, the gradations of tone are better preserved than by those processes which give very intense blacks.

ALCOHOLIC SOLUTIONS FOR NEGATIVES.

No. 1	Alcohol of 36°	1000	grammes.
	Collodion	10	,,
	Iodide of Potassium	10	,,
	Cyanide ditto	1	,,

Or,

No. 2	Alcohol of 36°	1000	grammes.
	Camphor	15	,,
	Solution of Lac in Spirit	5	,,
	Iodide of Potassium	8	,,
	Cyanide ditto	2	,,
	Fluoride ditto	2	,,

The advantage of these solutions is, that the whole of the paper we wish to prepare can be put at once into the bath, as the alcohol penetrates the mass with the greatest facility. The salts and resins should be powdered and put into the alcohol in a stoppered bottle where they should be left for two or three days, the bottle being frequently shaken. If at the end of this time anything remains undissolved, the solution should be filtered through blotting paper. Place the paper and solution in a pan, which can be closed by a glass plate to prevent evaporation, and shake it to make the alcohol penetrate the paper. After a quarter of an hour, remove the paper and allow it to drain for a minute or two into the pan; then pierce through the corner of the whole mass with a silver needle, and draw a string through it which you can suspend across the room. Separate the sheets on the string and allow them to dry. In this manner a great many sheets may be prepared in a very short time. This paper will keep for a very long time. The remainder of the process is the same as for waxed paper. M. Le Gray does not state the strength of either the collodion or the solution of lac in spirit.

NOTES TO THE NEGATIVE PROCESSES.

A Rice 3500 grs., (7oz., 2drachms., 20grs.), isinglass 350 grs., water 3 qts. I find the following the best way of proceeding. Put the rice and isinglass into the cold water, then place the whole on the fire until it boils. When it has boiled gently for about half-a-minute, remove it from the fire and strain at once through a sieve. When the liquor is cold it must be again strained, either through a very fine cloth, or through paper. The isinglass, although useful in making the solution take to the paper, may be omitted without affecting the results of the process, and unless you are going to use up all the solution in a very short time it is better to do so, as the isinglass soon becomes putrid, while the solution prepared without it will keep for many months quite sweet.

B	Sugar of Milk	393·78	grains.
	Iodide of Potassium	131·26	,,
	Cyanide of Potassium	7.00	,,
	Fluoride of Potassium	4·37	,,
	Rice Water	1	pint.

The fluoride of potassium may I think, be omitted. I have never found it make the slightest difference in the result. The cyanide is useful, as it removes the spots in the paper caused by the presence of metallic oxides, principally oxide of copper.

C	Nitrate of Silver	308·64	grains.
	Glacial Acetic Acid	370·36	,,
	Animal Charcoal	123·45	,,
	Distilled Water	4629	,, About 10·5oz.

D	Whites of ten Eggs		
	Iodide of Potassium	62	grains.
	Bromide of Potassium	8	,,
	Chloride of Potassium	8	,,

E	Isinglass	465	grains
	Water	1	quart.

F	Warm Solution of Isinglass	13	f. oz.
	Iodide of Potassium	200	grains.
	Bromide of Potassium	62	,,
	Chloride of Sodium	31	,,

PHOTOGRAPHY ON GLASS.

NEGATIVES BY COLLODION, &c.

Much discussion has recently taken place, as to who first proposed the use of Collodion as a substance upon which photographs might be obtained. The question who first suggested its use? is more easily asked than answered. I myself heard its use proposed by a friend, in 1847, almost immediately after Professor Schoenbein had announced that rather bad gun cotton would dissolve in ether; and before collodion had come into use for surgical purposes. It is however easier to say who first published any account of the method of using it. This was undoubtedly Le Gray, in the Appendix to his work, "Traitè Pratique de Photographie sur Papier and sur Verre," published in June 1850; a translation of which, by Mr. Cousens, was published a few weeks afterwards, by Messrs. T. & R. Willats. The Appendix seems to have been most curiously overlooked by most: in it he says, "I am now making use of the following process on *Glass:*—Fluoride of Potassium or Sodium is dissolved in alcohol of 40°, mixed with sulphuric ether, and then saturated with collodion. I act on this with aceto-nitrate of silver, and I obtain a picture in 20 seconds, in the shade; I develop the image by a solution of protosulphate of iron, and fix with hyposulphite of soda. By the use of ammonia and bromide of potassium, I get great variety of sensibility. The application of the solution to the glass, is extremely easy. I hope, by this means, to obtain portraits in 2 or 3 seconds." Although these are but vague directions, they are quite enough to establish Le Gray's right to be considered the first who pub-

lished the collodion process, as they contain all the essential points, viz: the addition to collodion of an alcoholic solution of some salt, capable of giving with nitrate of silver, a precipitate sensitive to light; the reduction of the solution to a proper consistence by ether; and the spreading of the liquid thus obtained, on glass plates. The substitution, by Mr. Archer, of iodide of potassium, (a substance in constant use in photography) for the fluoride or bromide of Le Gray, can only be regarded as an improvement on a process already before the public. Mr. Archer, in his late letter, claiming to be the originator of the Collodion Process, says that if Le Gray tried experiments on collodion in 1849, he did not give the public the advantage of following him, and that in his work of 1850, the subject is dismissed in three or four lines. Though Mr. Archer's communication to "The Chemist," extends to a much greater length, does he really give the public more information about his process, than Le Gray does concerning his? The public may judge of this, by perusing the following extract from "The Chemist" of February 18th, 1851:

"The imperfections in paper photography, arising from the uneven texture of the material, however much care may be taken in the manufacture of it, and which from its nature, being a fibrous substance, cannot, I believe, be overcome, has induced me to lay it aside and endeavour to find some other substance more applicable, and meeting the necessary conditions required of it, such as fineness of surface, transparency, and ease of manipulation.

"A layer of albumen on glass answers many of these conditions, producing a fine transparent film, but it is difficult to obtain an even coating on the glass plate; it requires careful drying, and is so extremely delicate when damp, that it will not bear the slightest handling; besides these objections, the necessity of having a large stock of glass when a number of pictures are to be taken, is much against its general use. My endeavour, therefore, has been to overcome these difficulties; and I find, from numerous trials, that *collodion*, when well prepared, is admirably adapted for photographic purposes as a substitute for paper. It presents a perfectly transparent and even surface when poured on glass, and being in some measure tough and elastic, will, when damp, bear handling in saveral stages of the process.

"I will now give a short outline of my mode of using it. The first

step in the process is to prepare the solution of collodion. There are several ways of doing this, but I will briefly allude to two.

" Pour a quantity (say 1 oz.) of collodion into a bottle containing dry iodide of silver to settle. The collodion will, in this way, take up a certain quantity of the silver salt, and become opaque; it should then be transferred to another bottle containing iodide of potassium, to be again well shaken up until the iodide of silver is entirely dissolved, and the solution becomes perfectly transparent.

" Or this :—To a solution of iodide of potassium in spirits of wine, add a small quantity of iodide of silver sufficient to saturate the iodide of potassium; let, however, the latter salt be in excess.* Add a small quantity of this solution to the collodion, between five and ten grs. by measure to 1 oz. of collodion will be sufficient, and if any of the iodide of silver should precipitate, a small quantity of iodide of potassium must be added to dissolve it. In this way, or by the former mode, the collodion may be prepared.

" The next step is to spread this solution evenly on a plate of glass. This can be done by pouring a sufficient quantity on the glass to run in a body freely. When it has entirely covered the glass plate, let the superabundance be drained off at one corner into the bottle again; this operation cannot be done too quickly, for the ether rapidly evaporating would prevent the collodion running evenly over the surface of the plate, and from its becoming too thick.

" The plate is now plunged into a bath of nitrate of silver, allowed to remain there for a few seconds, and then washed in water. (This washing is intended to remove all the ether from the surface of the collodion, which, if allowed to remain, would cause an unevenness in the sensitiveness of the surface, producing streaks or spots.) Immediately after washing, it may be exposed to the action of light for the time necessary to obtain a picture. This picture can be developed either by gallic or pyro-gallic acid. If the latter acid be used, a few precautions are necessary, to which I will allude presently. The former acid may be used as a bath, in the ordinary way. After the picture is developed, the film of Collodion should be loosened from the edges of the glass plate with a flat glass rod. By doing this, it will easily separate from the plate and can be allowed to float freely in the water bath, previous to being

* If the iodide of potassium be saturated, how can it be in excess ?

placed in the bath of hyposulphite of soda, and then again thoroughly washed.

" The drawing can now be mounted on a plate of glass, and when dry can be varnished, to protect it from injury.

" If thought more convenient (and, in fact, this mode is the best when pyro-gallic acid is used), the film of collodion, after being exposed to light and the image developed, can be removed from the glass plate (leaving the fixing and final washing to be done at leisure) by rolling it up on a glass rod, thus:—Take a sheet of ordinary white wrapping or thick blotting paper (if glazed it will be better), about the same breadth, and about one third longer than the drawing to be removed, soak it in water, and place it with the glazed side in contact with the surface of collodion. Turn the end of the collodion picture over the edge of the paper lying upon it, then place the glass rod just within the edge, and commence rolling it upon the rod; with a little dexterity, this can be accomplished without injuring the drawing. The cylinder thus formed, is easily removed from the glass rod, and can be preserved for any length of time in this state by being kept damp and away from the light, to be finally fixed at some more convenient time. Thus one plate of glass will be sufficient to make any number of drawings upon, the above operations being repeated for each picture.

" The plate of glass should be rather larger than the drawings intended to be made upon it, to allow for rough edges, &c. The back of the glass may be ground to get the focus upon, and one side should be formed into a kind of handle to prevent the hand of the operator being near the solution when the glass is in use.

" Thirty grains of nitrate of silver to one ounce of water will be sufficient for the nitrate of silver bath.

" Three grains of pyrogallic acid to one ounce of water, to which must be added about one drachm of acetic acid.

" Between five and ten grains of nitrate of silver to one ounce of water.

" The two latter solutions are to be mixed in equal proportions when a picture is to be developed. A wide-mouthed glass measure will be necessary to hold this mixture.

" I have found it convenient to have a trough made of gutta percha, the two sides and bottom of which are about one-eighth inch high and

just large enough to hold the glass plate. With this trough the mixed solution can be poured rapidly over the plate, without fear of any being thrown over the edges."

It will be observed that in this letter not a word is said of the method of making collodion, or the strength of the solution to be employed; the quantity of iodide of potassium and silver is also left an open question, so that beyond the use of the iodides of silver and potassium in collodion, the public was left much where it was before, excepting that its attention had been fairly drawn to the subject. Subsequent experience has shewn that it is better to omit the iodide of silver, and add only the alkaline iodide to the collodion, as that containing silver soon spoils, and is never so tough as that prepared without it. Some operators indeed still prefer collodion containing silver, I shall therefore in the following section give one or two formulæ for its preparation.

PREPARATION OF COLLODION.

The greater number of photographers prepare their collodion by various slight modifications of a process first published by M. Mialhe, in which cotton is acted on by a mixture of finely powdered nitre and common oil of vitriol

Mr. Mayall gives the following formula:—

Clean dry Cotton	80 grains.
Finely powdered and dry Nitrate of Potash ..	3 ounces.

Mix the nitre intimately with the cotton in a basin, and pour upon it 3 f. ounces of strong sulphuric acid. Then, with two stout glass rods, knead the cotton in the acid for about four minutes, or until the mass begins to fume; then quickly plunge the whole into an excess of water, and wash out all trace of acid and dry. This quantity of cotton is to be dissolved in 1 pint of sulphuric ether for negatives, or 1 quart for positives. To every pint of collodion add about 14 grains iodide of silver, and 12 grains iodide of potassium.

Le Gray's directions for making the gun cotton differ but little from these, but his method of iodizing being essentially different, I shall give his process entire:—

"Dry Nitrate of Potash in fine powder	80 grammes.
Strong Sulphuric Acid (not fuming).. 120	„

Mix them well in a porcelain basin with a glass rod for about two minutes, then add 4 grammes of cotton. Keep the cotton stirred in the acid mixture for about ten minutes, then throw it into a large quantity of water, and wash till not acid, first in common, and then in distilled water. Press out the water with the hand, and afterwards between folds of blotting paper; then spread it on paper, and let it dry by exposure to the air, taking care to keep it free from dust. When quite dry put into a stoppered bottle the following ingredients:—

Sulphuric Ether of 62°	100	grammes.
Alchohol of 36°	25	,,
Gun Cotton	2	,,
Liquid Ammonia.....	5	drops.

When the cotton is dissolved, add one gramme of iodide of ammonium. When the solution is complete, filter it through fine linen into a dry bottle.

Iodide of potassium may be substituted for iodide of ammonium, but we must then add 10 centigrs. of pure iodine, and 2 drops of liquid ammonia.

Dr Diamond, in No. 151, of "Notes and Queries," recommends the following process as yielding, in his opinion, a collodion very superior to every other.

To prepare the gun cotton, "Place 100 grains of clean cotton in a large basin, and pour on it 1½ oz. of nitric acid previously mixed with 1oz. of strong sulphuric acid. Knead it with glass rods during five minutes, at the end of which time the cotton is to be plunged into cold water and washed as long as any trace of acid remains. The most convenient mode of drying it is to wring it in the folds of a towel, and then pin it up in small fragments to allow the air to have free access to it."

In these directions Dr. Diamond omits to mention the specific gravity of the nitric acid to be employed, although upon it depends the whole success of the operation.

This process is the one originally published by Mr. T. Taylor, in the "Times," before Professor Schoenbein had made known his mode of preparing gun cotton. Mr. Taylor, however, particularly mentioned

that acid of sp. gr. 1500 must be employed, his purpose being to obtain a cotton as powerfully explosive as possible. This cotton is, however, insoluble in ether, and therefore quite unfit for making collodion. I presume Dr. Diamond must mean to recommend acid of sp. gr. 1450, as that is about the strength usually sold. This yields a soluble cotton, but I have never yet succeeded by the use of nitric acid of any sp. gr. in making really good collodion.

If Dr. Diamond pay but little attention to the sp. gr. of his acid, it is not surprising that he finds it impossible to say precisely the proper quantity of iodizing solution to be employed, as doubtless his collodion is never twice exactly alike. If the collodion be of the same quality, the quantity of iodide must always be the same.

Dr. D. proceeds. "To prepare the Collodion:—About 50 grains of this cotton put into a pound of ether will dissolve and form collodion of the required consistency. The ether used should be the common rectified ether not washed; and should the operator find he has obtained an ether which will not dissolve the cotton, a portion of spirits of wine may be added in a proportion not exceeding one-tenth of the ether. This may be either allowed to subside or be strained off immediately through an old silk handkerchief, and is then in a fit state to iodize."

"To iodize the collodion dissolve 30 grs. of nitrate of silver and 30 grs. of iodide of potassium, each in 4 oz. of water, and mix the solutions; wash the precipitated iodide of silver frequently in distilled water, and when almost dry, place it in a bottle with 1½ oz. of alcohol. Drop into this mixture iodide of potassium till the iodide of silver is completely dissolved, when it is fit for use. It is difficult to determine how much of this solution should be added to the collodion, probably 10 or 12 drops to the ounce, but it should be added until the collodion, when poured on a piece of glass and immersed in the bath of nitrate of silver, assumes a semi-opaque, opal-like appearance. Should the collodion then appear very turbid, a little spirit of wine may be added."

Various additions have been from time to time proposed to the ingredients here recommended, some for the purpose of rendering the collodion more tough, and others for increasing its sensibility, thus Mr. Fry recommends the addition to the iodized collodion of a piece of gutta percha, the small quantity of which that dissolves, is said to render the collodion much stronger. In a late No. of "Notes and Queries," amber

is recommended for the same purpose. Amongst the accelerating substances may be mentioned bromide of potassium, fluoride of potassium, arsenious acid, and iodide or bromide of iron. None of those who recommend these substances, state the quantity in which they are to be added; I have myself found no advantage from their use for ordinary purposes, but I am informed that for working by artificial light, as in copying microscopic objects with a camphine lamp, the bromide of iron is really useful.

The following process, (a slight modification of one with which I was kindly favoured by Mr. R. Murray,) gives by far the best collodion I have ever seen, being much more tough than those previously described, and requiring about half the time of exposure in the camera:—

Mix in a wide-mouthed stoppered bottle,

Nitrous Acid, sp. gr.	1460.....	½ f. oz
Sulphuric Acid, ,,	1827	½ f. oz
Nitric Acid, ,,	1500.....	20 mins.

Add to this mixture 30 grs. of Swedish filtering paper, (good tissue paper made from linen may be employed, but it is not so good,) put in the stopper, and allow the paper to soak at least three hours: it may be left for 12 or even 24 hours without danger. Pour off as much of the acid as possible, plunge the paper into a large quantity of water, and wash it till every trace of acid is removed, first in common and then in distilled water; then dry it by a gentle heat.

Dissolve 5 grs. of iodide of potassium in 2 drachms of spirit of wine of 59 over proof, add to it 6 drachms of ether sp. gr. 0.738, and lastly 6 grs. of prepared paper; let the mixture stand, shaking it occasionally for 12 hours, and then filter through fine linen, or better still, through swansdown. Be careful to add the ether gradually to the alcoholic solution of iodide of potassium, as if the latter be poured at once into the ether, the salt will precipitate. Instead of the above, the following solution is preferred by some:—

Iodide of potassium 5 grains, iodide of ammonium 3 grains, dissolve in ½ oz. of spirits of wine, add 1½ oz. of ether, and 12 grains of paper.

The ether here recommended is Howard's extra light ether, and is, though so light, unwashed, it is the best that can be employed. Should

any one not be able to obtain it, common unwashed ether may be substituted, but less spirits of wine must be used. With ether of sp. gr. 0.740, the iodide must be dissolved in 1½ f. drachms of spirit, and 6½ f. drachms of ether must be added.

The collodion may be made with still greater certainty by employing absolute alcohol and dissolving the iodide in water, using one drop of water for each grain of iodide ; this solution is mixed with the alcohol and the ether poured into it.

The great advantage which paper possesses over cotton, is the facility with which every trace of acid can be removed from it A much larger quantity of it can also be employed, whereby great depth is given to the blacks of the picture, and the middle tints are much more perfectly preserved. The film being so much thicker, is, of course, much less easily injured. The iodide of silver formed on immersing the plate in the nitrate of silver, is also much more perfectly adherent to the collodion, so that you are never troubled with particles floating on the surface of the solution, as is constantly the case when collodion prepared from cotton is employed.

A skilful operator can work with the collodion thicker than is here recommended, as much as 7 or 8 grs. of paper to the oz. being used by some, it is however difficult to get an even film on the glass with such thick collodion, and though greater depth of tone and increased solidity are obtained, I think the proportions above directed are the best for ordinary purposes.

MANNER OF COATING THE GLASS WITH COLLODION.

The edges of the glass plates being first ground, they must be rendered perfectly clean and free from grease. For this purpose they may be washed in solution of soda, or in liquid ammonia, and afterwards in plenty of clean water, and dried with a cloth which must itself be cleansed from grease by washing in a weak solution of soda, and afterwards in clean water.

Le Gray recommends the use of spirits of wine holding a little fine tripoli powder in suspension, which is to be applied with a bunch of papier Joseph, and the plate then rubbed clean with some fresh pieces of

paper. I have found nothing answer so well as infusion of galls, a liquid constantly used by microscopists for removing grease from their slides. However they may have originally been cleaned, the plates should immediately before they are used be polished on a buff of velvet, or chamois leather, similar to those used for polishing daguerreotype plates.

The plate being perfectly clean, take it by one corner in the right hand, and with the left pour a good quantity of collodion on to its centre. Spread this entirely over the glass by inclining it gently in every direction. Pour off the excess of collodion at the corner opposite to that by which you hold it, bring the plate into an upright position, and draw one edge of it along the mouth of the bottle; then immediately place it perfectly horizontal, and give it a slight tremulous movement, which completely removes all the streaky appearance from its surface. As soon as the collodion begins to set, it is ready to be placed in the bath of nitrate of silver. If the plate be too large to be held by one corner, some other part of it must be supported. Nothing is better for this purpose than the support directed by Le Gray, viz., a bottle with the top of the cork rounded. On this you rest the centre of the plate, and holding it by one corner you can readily give it all the necessary motions.

GIVING SENSIBILITY TO THE PLATE.

The solution for this purpose is composed of:—

Nitrate of silver	300 grains
Distilled water	10 oz.

This solution is contained in a trough of glass or gutta percha, rather larger than the plate to be immersed, and about $\frac{1}{2}$ or $\frac{3}{4}$ of an inch wide, placed in a sloping position. Into this the plate is to be plunged with one uniform movement, as any stop produces lines across the collodion surface. This immersion is best effected by placing the plate on a glass dipper, made by cementing a slip of plate glass, about a $\frac{1}{4}$ in. wide, on the end of another slip of 8 or 9 inches long, and $1\frac{1}{2}$ or 2 inches wide. The plate is laid with its uncoated surface on the long slip, and its

lower edge resting on the cross slip; the position of the plate and trough will be understood at once by an inspection of figure 2. The plate will almost directly become coated with a yellow iodide of silver. It must be examined occasionally, and as soon as the liquid remains in a uniform film over its surface, it must be removed to the camera, and exposed as rapidly as possible. It has lately been recommended to add some alcohol to the solution of nitrate of silver, and it seems certainly to give a more uniform coating to the plate. It is usual with the alcohol to use rather a stronger solution; the following are the proportions generally employed:

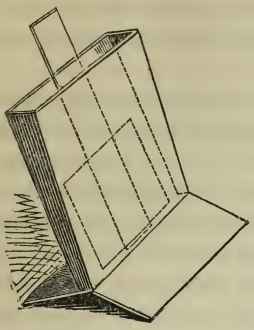


Fig. 2.

Nitrate of silver	400 grains.
Alcohol.....	4 f. drachms.
Distilled Water	10 f. oz.

It is said by some, that a new sensitive bath does not give a uniform coating to the plate; this they attribute to the nitrate of silver dissolving a small quantity of the iodide of silver at first formed, to prevent which, they recommend that a little iodide of potassium should be added to the nitrate of silver solution; this precipitates a small portion of iodide of silver, which is redissolved by the nitrate, and prevents its afterwards attacking the coating on the plate; should any iodide of silver remain undissolved, it must be separated by filtration. I have never found this part of the process necessary.

The plate being properly coated, it is removed from the bath, the liquid allowed to drain off at one corner, and then placed in the camera frame, which should be placed in an upright position, the edge of the plate from which the solution has been drained being at the lower part of the frame, as if placed in any other position, drops of solution which have collected at that part will run over the surface of the plate and cause stains. Two or three folds of blotting paper should be placed over the back of the plate, before closing the door of the frame. Camera frames for this process are best when lined entirely with glass; at all events, the part on which the plate rests should be made of that material. Should the

operator be unable to obtain a glass frame, the best thing he can do is to place small pieces of blotting paper over those parts of the frame on which the plate is to rest, as wood is very apt to cause stains on its surface, besides becoming very much spoiled by being kept constantly wet with the moisture from the plate.

It is quite impossible to state precisely the length of time during which the plate must be exposed in the camera, as it will vary with the state of the light, and the construction of the lens. I may mention however, that with a good double combination of 2 inches apperture, and 8 inches focal length, the day being moderately bright, a good portrait may be obtained out of doors in the shade, in from 3 to 5 seconds. The plate should always be exposed as soon as possible after it is rendered sensitive, as its sensibility declines rapidly as it drys. Some have recommended having a glass bath for the nitrate of silver fitted to the back of the camera, and exposing the plate whilst in the solution, but the action of the light is materially decreased by having to pass through the side of the bath, and perhaps still more by the film of solution of nitrate of silver, which stops many of the chemical rays.

DEVELOPMENT OF THE PICTURE.

The most common agent for this purpose is a solution of pyrogallic acid, mixed with acetic acid. The precise strength of the solution depends on the length of time which has been required to produce the picture; in general, a stronger solution being required as the intensity of the light diminishes, and consequently the time of exposure increases. The following is the solution generally employed:—

Pyrogallic Acid	3 grains.
Distilled Water	2 f. oz.
Glacial Acetic Acid.....	1 f. drachm.

Pour about 2 drachms of this solution over the surface of the glass which is kept gently agitated to prevent stains forming on the surface. After about two seconds pour off the solution, and if the blacks have not a decided and intense appearance, add to the solution three or four drops of a solution of nitrate of silver of the strength of 30 grains to the oz., and

again pour it on the plate. As soon as all the details of the picture are well defined and the blacks very intense, which will generally be the case in from ten to twenty seconds, pour off the solution and wash the plate well by pouring water gently on to it, when it will be ready for fixing.

I have found solution of pyrogallic acid of half the above strength answer perfectly on a bright day, and indeed give better pictures than the stronger solution.

Various methods have been devised of applying the developing solution, some operators preferring one, and some another. One of the most convenient is to place the plate face upwards on a small glass tripod* standing in the middle of a dish, and pour the developing solution rapidly over it, any which may run over the edges being caught in the dish. The plate can also be washed without removing it from the stand by pouring water on to its centre and allowing it to flow over into the dish. Mr. T. Ross recommends a trough of plate glass rather larger than the plate, about 3-16ths of an inch deep, and having only three sides, the open end being slightly raised by cementing a slip of glass under it. In the inside of this trough are cemented two slips of thin microscopic glass, on which the plate may rest so as not to come in contact with the bottom. A small quantity of developing solution being poured into the trough, the plate is laid face downwards on the slips of thin glass. Capillary attraction draws the liquid up between the plate and the bottom of the trough, and thus a very small quantity of solution may be made to cover a comparatively large plate. By placing a sheet of white paper under the trough the development can be watched without removing the plate. When the development is complete the plate must be washed as before directed. A saturated solution of gallic acid may be substituted for the pyrogallic acid, but I do not think the results are so good. If this acid is used it is better to plunge the plate completely into a bath of the solution in the same way as it is put into the bath of nitrate of silver. Solutions of the protosalts of iron (principally the sulphate and nitrate) are by some preferred to either gallic or pyrogallic acids. M. Le Gray gives the following formula for the preparation of developing solution :—

* Should the operator not have a glass tripod, a small wine or liqueur glass answers the purpose very well, the plate being laid on the mouth of the glass.

" * Distilled Water	500	grammes.
Proto Sulphate of Iron	50	,,
Sulphuric Acid	10	drops.
Acetic Acid	10	grammes.

The plate is completely immersed in this bath, which will serve to develop a great many pictures; the development should be complete in three or four seconds. Should the proof not be sufficiently vigorous when withdrawn from this bath, it may be much improved by placing it in a bath of gallic acid containing a small quantity of aceto-nitrate of silver." The proto-nitrate of iron being chiefly used for the development of positive images, I shall give the formula for its preparation under that head.

M. Le Gray asserts that the tone of the picture thus obtained, is more harmonious than that of those developed by pyrogallic acid, and that the middle tints are better preserved; I have not found this to be the case, if good collodion be employed, moreover the blacks are never so intense.

FIXING THE NEGATIVE.

This is done by pouring on to the surface of the plate a nearly saturated solution of hyposulphite of soda, allowing it to remain until the whole of the yellow iodide of silver is removed and the whites of the picture appear perfectly transparent. If it be preferred, the plate may be immersed in a bath of the fixing solution, but the film of collodion is apt to become detached from the glass if it be too often completely immersed in various solutions. Hyposulphite, which has been frequently used, is preferred by some, as it is less likely to weaken the black parts of the picture; it takes however a longer time to dissolve the iodide of silver, and if the negative be really good and forcible, new hyposulphite does it no injury. As soon as the solution of the iodide of silver is complete, pour off the hyposulphite and wash the plate well in water. After a good quantity of water (say at least half a pint) has been poured over

* Distilled Water	1	pint.
Protosulphate Iron	875	grs.
Sulphuric Acid	12	drops.
Acetic Acid	164	grs.

the plate, it should be allowed to remain for an hour or two under as much water as can be made to stand on its surface, the water being changed frequently (say every ten minutes) during this time. This long washing is particularly necessary with the paper collodion, as from its greater body it retains the hyposulphite much more firmly than collodion prepared from cotton. If the hyposulphite be not entirely removed, after two or three days it crystalizes all over the plate, and completely spoils the picture. After being well washed, the plate is placed in an upright position with its lower edge resting on some blotting paper, and allowed to dry spontaneously.

M. Le Gray recommends a solution of 2 grammes of persulphate of iron in a litre of water instead of hyposulphite of soda for fixing the negative; he admits, however, that it leaves the light parts of an opaque yellow tint, which somewhat interferes with the subsequent printing process; nevertheless, he says that it increases the force of a feeble proof, and enables you to print from it when you could not do so had it been fixed by hyposulphite of soda. The solution should remain on the plate about forty seconds, as too long an exposure completely removes the image. I have not myself tried this mode of fixing, so can give no opinion of its efficacy.

When the proof is perfectly dry, it must be varnished to prevent its being injured in the printing process. Various varnishes may be used for this purpose. The one I have found answer the best, is that made by dissolving gum damma in turpentine: it should be of such a thickness as to run readily over the plate. It is applied to the glass precisely in the same manner as the collodion, the plate being previously heated as hot as the hand can bear. Common mastic varnish reduced to about half its ordinary thickness with turpentine may also be employed, but it remains much longer sticky. White hard varnish thinned either with turpentine or absolute alcohol, also answers very well. Some operators employ pale laquer, which is a remarkably good and hard varnish, and possesses the advantage of enabling you to print from the negative immediately. It requires, however, considerable skill to use this varnish properly; the plate must be made very hot and kept so after the varnish has been applied until it is quite dry, otherwise it becomes opaque. I have also sometimes found that it dissolves the picture completely off the glass. I have not yet been able to ascertain to what this is owing.

Dr. Diamond gives the following receipt for a varnish which he strongly recommends :—

"Powder 2 drachms of amber, and macerate for 3 days in 2 oz. of chloroform; shake it often and filter it for use through thin blotting paper. The chloroform dissolves a hard resin from the amber, and leaves its bituminous components untouched. Another varnish may be made by macerating amber in naptha or benzole; it does not dry so rapidly as the preceding, and has some colour; but when large surfaces are to be covered, it is from its comparative cheapness a desirable coating, as it perfectly protects the picture." Dr. Diamond recommends the broken mouth pieces of pipes for this purpose as they are generally made of the finest and most transparent kind of amber.

If a negative appear very feeble after being fixed, it may often be much improved by the action of a solution of corrosive sublimate. Dr. Diamond recommends dissolving half an ounce of corrosive sublimate in one ounce hydrochloric acid, and afterwards adding one ounce of water. I have always employed a nearly saturated solution of corrosive sublimate in water as it has not so great a tendency to render the collodion rotten. A small quantity of the solution being poured on to the plate the blacks gradually become white, and a very agreeable positive is often produced; as soon as this is the case, wash the plate in water, and again apply the solution of hyposulphite of soda; almost immediately the color is again changed to black, and generally far more intense than that of the original picture; it has now only to be well washed, dried and varnished, as already described.

Instead of varnishing the collodion while on the glass, it may be transferred to paper, and where easy package is an object, this is the best method of proceeding. It is however a difficult and delicate operation, and can only be performed with very good collodion. The following directions from Le Gray's work are, I think, the best I have seen for this process.

"After the proof is fixed, place it in a bath of water acidulated with acetic acid, and leave it until one corner of the collodion becomes detached from the glass. Then allow a fine stream of water from a small cock to flow between the collodion and the glass, by letting it fall on the corner of the glass which is uncovered; this must be done patiently and with great caution. When the water flows freely between

the collodion and the glass, place the plate horizontally on some folds of of paper.

Cut two pieces of very thin and transparent paper rather larger than the plate. Soak them in pure water, and remove the excess of moisture by pressing them between folds of blotting paper. Cover one side of each piece with a solution of dextrine made just so thin as not to draw into threads when taken up on a brush. Place one of these pieces on the collodion in such a manner as to exclude air bubbles, lay upon it a plate of glass somewhat larger than that on which the picture was taken, and press strongly upon it to bring the paper and collodion into perfect contact. Turn over both the glasses, and remove that on which the picture was originally taken, by pushing it off horizontally. The collodion remains adhering to the paper, but still presents some inequalities of surface, and sometimes even retains some bubbles of air; to get rid of these imperfections, lay the second piece of paper over the collodion, in such a manner as to inclose the latter between the two sheets of paper. Lay over the whole some folds of blotting paper, and rub strongly on the top with the hand, to expel the excess of dextrine. Finally, rub over the whole with a plate of agate or marble, which serves as a kind of burnisher, and insures perfect contact. Remove the picture from the glass and hang it up to dry; when dry it must be waxed in the same manner as a proof on paper.

These proofs possess one advantage over those on glass besides their greater indestructability, *viz:*—that we can touch up any little white spots or flaws in the collodion, which is not easily done on glass."

NEGATIVES BY ALBUMEN.

The albumen for this purpose may be prepared precisely as directed for the preparation of albumenized negative paper, or if preferred, very good results may be obtained by the use of iodide of potassium or ammonium in the proportion of 1 gr. of iodide to every 100 of albumen, the whole being beaten into a thick white froth, allowed to stand for twelve hours, and the clear liquid decanted.

The glass being perfectly cleaned as directed for the collodion negatives, place it on a levelling stand and pour an abundance of

albumen upon it. Incline it in every direction to make the liquid flow all over it, and pour off the excess at one corner. Replace the glass on the levelling stand, and allow it to dry in a perfectly horizontal position, preserving it from dust by a cardboard cover, or any other convenient means. The plates may be preserved in this state for any time. To render the plate sensitive, hold it to the fire to remove the last trace of moisture, and then immerse it in a bath composed of

Nitrate of Silver	305 grains.
Distilled Water	10 oz.
Acetic Acid	$1\frac{1}{4}$ oz.

The plate is immersed in the same manner as the collodion proof; after two or three minutes, remove the plate from the bath, wash it well in distilled water, and allow it to dry in perfect darkness; it will preserve its sensibility for two or three days.

The image is developed and fixed in precisely the same manner as those obtained on paper; the time of exposure in the camera is however much longer, from half an hour to an hour being required to obtain a good proof.*

The Rev. W. Kingsly recommends the addition to the albumen of a small quantity of bromide of iron, having the bromine slightly in excess; he says, by this means he obtains pictures with almost as great rapidity as on collodion; he does not however state the quantity he employs.

The following letter, published by Mr. Reeves in "The Expositor," describes a process by which an even coating on the albumen is more easily obtained; it yields in the hands of its author very beautiful results.

"Take an ounce measure of the white of egg, add to it seven grains of iodide of potassium, and two grains of bromide of potassium; shake it up in a bottle until the whole forms one mass of froth, which will not run on the bottle being inverted. In two or three hours sufficient liquid will have separated to coat the plates. Procure a glass tube about an inch in diameter and six or eight long, and tie over one end

* M. Le Gray states that both the time of exposure, and that required for developing the image, may be much decreased, by using instead of the gallic acid a saturated solution of proto-sulphate of iron, to which one tenth of its bulk of glacial acetic acid has been added.

a piece of fine linen. The above albumen is then poured into this tube and forced out by blowing, on the glass plate, which must first be cleaned not with strong nitric acid, but by a few drops of spirit and a little chalk, on a piece of clean leather. The albumen is now forced through the tube on the plate, which is held horizontally on the finger. The diffusion of the liquid might be facilitated by spreading it with the edge of another piece of glass. An excess ought to be placed on the glass and made flow all over, by inclining the plate from side to side. The excess is then made to flow off at one corner into a glass, to be returned to the tube when required. The plate should not be drained much, as a thin coat is not so sensitive as a thicker. The coated plate is better put aside on a horizontal board and covered over while another is prepared in a similar manner. A square tin vessel is to be procured, of dimensions not less than two inches greater than the glass to be coated. A piece of thin plate glass is to be supported on the inside in a horizontal position, and about an inch less each way than the tin vessel. This vessel ought to have a cover in the form of a pyramid, that the steam might trickle down the sides and not drop on the prepared plate. An iron tripod-stand sufficiently high to admit a chauffer underneath, with an adjusting-screw in each foot, is the best support, as it allows the apparatus to be levelled with the greatest nicety. When the apparatus boils,* put the glass first prepared on the middle of that which was levelled in the boiler, and place the cover on. In about two minutes the albumen is coagulated firmly, and will bear rubbing when wetted. If the plate is not kept in long enough it will be soft when wetted, and subject to all the difficulties the other processes were. If it is kept in too long it will be liable to crack, the commencement of which might be noticed around the edges, and should be the signal to remove it. The coating is best dried by leaving it in the boiler, while the cover is placed crossways over the plate to prevent dust from falling on it; the steam then escapes, and the albumen quickly dries and becomes transparent. It will be observed that in this process the coagulation takes place in an atmosphere of steam, which is essential, otherwise the thin film would dry before arriving at the necessary temperature, and coagulation would be impossible, coagulated albumen being a hydrate—a fact not mentioned before in connexion

* We presume Mr. R. means water to be put into the tin vessel and then made to boil.

with this process, and which rendered the other published processes so difficult, the coagulation in their case being generally performed by the acetic acid of an after operation, and not by the heat. This coagulation is soft, and very difficult to obtain without lines called ripple *marks*. Prepared glass plates are best preserved in a daguerreotype-plate box. To make them sensitive, dip them into a solution of aceto-nitrate of silver, consisting of about thirty grains of nitrate to an ounce of water, and one-sixth its bulk of strong acetic acid; to which add one-eighth of alcohol. The plate is then removed and well washed in water, and placed in the camera wet or dry; in the latter case it is less sensitive. If a very sensitive plate is required, it must not be washed at all, but placed in the camera immediately, as it does not do well to allow it to dry in that state. When the exposition in camera has taken place, the picture is developed by placing the plate first in the nitrate of silver before mentioned, and then in a saturated filtered solution of gallic acid, sufficient to cover the plate. When well developed, which might be known by holding the plate up before a candle, it is desirable to wash it with cotton and water to remove any surface deposit. Strong hypo-sulphite must not be used for fixing, as it is liable to detach the coating from the plate, but bromide of potassium of twenty-five grains to six ounces of water. The glass must be washed previous to going into the bromide of potassium, and also after.

The process which I have detailed I have carried largely into practice, it is simple and certain in its results. I and Mr. Nichols first used the steam-bath four or five years since, but could not succeed to our satisfaction until I again turned my attention to it last spring.

THOMAS REEVES."

N.B.—Plenty of water must be kept in the boiler, and sustained briskly boiling.

PREPARATION OF POSITIVE PAPER.

It is difficult to give more than general directions for the preparation of positive paper, as the precise proportions of the various ingredients to be employed must depend on the tone of color the operator wishes to produce, and must also be modified according to the paper that is employed. It may in general be said that the French papers of Canson Frères are best suited for the production of black, and the English papers of Turner or Whatman for that of brown or reddish tints.

All positive processes mainly consist in impregnating the paper first with a chloride or bromide of an alkalie, or alkaline earth, and subsequently washing it with nitrate of silver, by which means the surface of the paper becomes covered with a chloride or bromide of that metal.

Various methods are employed to spread the solution on the paper; some soaking the paper completely in the solution of chloride, others floating the sheet upon it so as to touch one side only, while some apply it with a brush. I have found the best results produced by applying the solution to one side only, and I believe nothing is better for this purpose than a clean sponge; it lays on the solution more perfectly than a brush, and is less trouble than floating the paper on to a bath of the solution. The solution of nitrate of silver may also be applied in many ways. By spreading some of the solution on a level glass plate and floating the sheet upon it. By pouring a small quantity of the solution on to the paper and spreading it with a glass rod. By means of a brush &c. Mr. Buckle recommends a bunch of clean cotton held in a glass tube by means of a silver wire, the cotton being changed as soon as it gets dirty. I generally use a piece of sponge tied on to a glass rod; by washing this occasionally in distilled water it may be used for a long time and answers the purpose perfectly.

I shall now proceed to describe some of the solutions more commonly employed, premising that they may be altered almost infinitely according to the taste of the operator, provided he take care always to employ the nitrate of silver in sufficient quantity to decompose all the chlorides present in the paper, as a small quantity of an alkaline chloride left undecomposed much impairs its sensibility.

No. 1. Hydrochlorate of Ammonia, or Chloride of Sodium 5 grs.
Water ..... 1 f. oz.

Wash the paper on one side only with this solution, and when it is dry apply—

Nitrate of silver..... 60 grs.
Distilled Water ..... 1 oz.

Some prefer washing the paper twice with a solution of nitrate of silver, 30 grs. to 1 oz. of water, allowing the paper to dry, or drying it at the fire, between the two washings. Ammoniacal solution of nitrate of silver may also be employed, and it is easier with this solution to obtain a perfectly even surface. The solution is made by dropping strong liquid ammonia into the solution of nitrate of silver above described, until the precipitate, which is at first produced, is nearly all dissolved; the undissolved portion is allowed to subside, and the clear liquid employed.

No. 2. Hydrochlorate of ammonia ..... ½ gr.
Water ..... 1 f. oz.

Followed by—

Nitrate of Silver ..... 20 grs.
Distilled Water ..... 1 f. oz.

This gives very delicate and pleasing tones, but they are more apt to fade than when a stronger solution is employed.

No. 3. Le Gray recommends—

Hydrochlorate of Ammonia .... 5 grs.
Distilled Water ..... 100 grs.

Followed by—

Nitrate of Silver ..... 15 grs.
Distilled Water ..... 100 grs.

This preparation, or No. 1, is the best to employ when the proof is to be fixed with chloride of gold as hereafter described.

No. 4.	Bromide of Potassium	10 grs.
	Water	1 f. oz.

Followed by—

	Nitrate of Silver	30 grs.
	Distilled Water	1 f. oz.

The amount of nitrate of silver employed with this proportion of bromide may vary from 25 to 60 grs. in the oz., and a variety of very pleasing tints be thus produced.

No. 5.	Chloride of Barium.....	5 grs.
	Water	1 f. oz.

Followed by—

	Nitrate of Silver	30 grs.
	Distilled Water	1 f. oz.

The ammoniacal solution of nitrate of silver may be substituted for the solution here named. Small quantities of chloride of barium, or bromide of potassium, may be mixed with any of the solutions of hydrochlorate of ammonia above mentioned, and in this way almost an endless variety of tints may be obtained. The paper, after being washed with the chloride solution, may be kept for any time, but the nitrate of silver should not be applied more than two or three days before the paper is used; indeed, it is better to use it as soon as possible after it has been made sensitive. It is almost needless to remark, that after the nitrate of silver is applied, the paper must not be exposed to light, and should be kept as much as possible from the air. Very pleasing effects may be produced by adding to the chloride solution, sugar of milk, grape sugar, or mannite, in the proportion of 4 or 5 grs. to the oz., darker tints, more approaching to black, are thus obtained. Isinglass in the proportion of 4 grs. to the oz. is also a very good addition to the chloride solution, especially if paper which has not a very good surface be employed.

POSITIVE ALBUMENIZED PAPER.

By the use of albumen, almost any paper may be made to yield good pictures. The details are in all cases more perfectly preserved than they can be on plain paper, however fine its grain.

To the whites of eggs add hydrochlorate of ammonia in any of the proportions recommended previously for making the chloride solution, 4 or 5 grains to the ounce answers very well. Beat the whole into a thick froth with a wooden or silver fork, allow it to stand for about twelve hours, and decant the clear liquor which subsides. Apply this liquid to one side of the paper, allow it to dry, and iron it, in precisely the same manner as directed for the preparation of negative albumenized paper. If the highly varnished appearance of this paper be thought objectionable, the albumen may be diluted with its own bulk of water.

To render this paper sensitive, it is placed with its albumenized side downwards on a bath of nitrate of silver, the strength of which may vary according to the tint we wish to obtain. With the proportion of hydrochlorate of ammonia recommended above, 60 grs. to the oz. gives very good results.

Mr. Henneman recommends the following proportions as yielding a very sensitive paper more particularly adapted for printing rapidly in dull weather.

White of Egg.....	1 f. oz.
Distilled Water.....	1 f. oz.
Chloride of Sodium	½ oz.

Followed by—

Nitrate of Silver	120 grs.
Distilled Water	1 oz.

PRINTING THE POSITIVE.

Place the negative face upwards on the glass of the pressure frame; over it a sheet of positive paper somewhat larger than the negative, with its prepared side downwards; then put the back board of the pressure frame in its place, and bring the negative into as close contact as possible with the positive paper, by tightening the screws at the back,

taking care to make the pressure as even as possible, otherwise the glass is apt to be broken. Then expose the frame to the light of the sun, in such a way that the rays fall perpendicularly upon the negative; bright sunshine is always preferable, as the proof requires less exposure, and the results are always more brilliant than those produced by a longer exposure to diffused daylight. If the back of the frame be jointed in the middle to enable you to see the progress of the printing, it is as well to place a sheet of card board between the positive paper and the back, as the working of the joint will sometimes tear the paper. Should the back not be jointed, the negative should be fastened to the positive paper at two corners by some gummed paper, in order that the back of the frame may be removed, and the picture from time to time examined without shifting one upon the other.

The time of printing will vary with the paper employed, and the tint required; it is always however necessary to allow the proof to become darker than it is intended to be ultimately, as it fades a good deal during the process of fixing. In general it may be said that the parts intended to be white, should be allowed to assume a light grey tint.

FIXING THE POSITIVE.

This is perhaps the most important operation in the whole process, not only because the stability of the proof is dependent on the care with which it is performed, but because infinite variety of tint may be produced by slight variations in the manner of conducting it.

Hyposulphite of soda is employed to fix the positive as well as the negative proof. It is found by experience that an old solution gives more agreeable tints than a new one; the fixing however is less perfect, and a proof fixed with old solution should always be placed for a short time in a fresh solution before it is washed, to be sure that all the salts of silver are removed. As old solution of hyposulphite is not always to be had, the same effect may be produced in the following manner:—

Dissolve 80 grs. of nitrate of silver in distilled water, and add to the solution, either a solution of salt or hydrochloric acid, until the whole of the silver is precipitated. Allow the precipitate to subside, and wash it repeatedly with water until all trace of salt or acid is removed; then expose it to the light till it is quite black. Afterwards dissolve it in the

following solution:—Hyposulphite of soda 1oz., distilled water 6 oz. Should a precipitate appear in this bath after frequent use, a little fresh solution of hyposulphite should be added to it, the whole allowed to subside, and the clear solution poured off. Wash the proof well in water to remove all undecomposed nitrate of silver, and then plunge it completely into the above solution, and allow it to remain at least an hour. The tint of the picture depends much on the time it is left in this solution, but less than an hour will not fix it perfectly. Remove it from this bath, wash it in water, and place it in a bath of new hyposulphite, containing one part of the salt to eight of water, let it soak for about ten minutes, wash it well in many waters and then allow it to float in a large basin of water for at least twelve hours, changing the water every hour, to remove all trace of hyposulphite. Should this not be done, the proof is sure to fade; even with the greatest care it is harldy possible to fix a proof so perfectly as to stand the action of a damp atmosphere, although it may be quite unalterable by light.

Some operators recommend placing the proof after it is fixed and washed, in a warm solution of carbonate of soda, and subsequently again washing; this is said to remove the hyposulphite more perfectly, it however much damages the tone of the picture.

M. Le Gray attributes the fading of the positives to the hyposulphite being partly decomposed during the process of fixing, and depositing sulphur in the pores of the paper. To remove this, he employs alcohol mixed with one-third of its bulk of bisulphide of carbon; the proof after being soaked in this solution, is to be washed, first in alcohol, and then plentifully in water; in this manner he says he obtains perfect fixation. He also recommends the addition of a little ammonia to the hyposulphite, not only as giving greater stability to the proof, but improving its color.

The following process for producing proofs of a very pure black and white colour, and in which all the details are very beautifully preserved, is also extracted from Le Gray's last work. It possesses, according to its author, not only the advantage of giving very beautiful tints, but that the proofs are quite unalterable. To the truth of the former part of this statement I can bear witness; I have not yet kept any proofs long enough to feel sure about the latter.

The positive paper is prepared in the ordinary way. The proof is

exposed to the light for a longer time than when it is to be fixed by the ordinary means. To obtain a proof of a blueish black colour in the dark parts, the whites should be allowed to become of a light violet color. To obtain a full black in the dark parts, the exposure should be long enough to make the whites of a very decided violet colour. And for a greenish black, the whites should be printed of a sepia tint.

After the exposure is complete, wash the proof well in water, to remove all undecomposed nitrate of silver. If weak solutions of nitrate of silver and hydrochlorate of ammonia have been employed, this washing may be omitted. Washed or not, place the proof in the following bath :—

Distilled Water	1000 grs.
Chloride of Gold	1 gr.
Hydrochloric Acid	25 grs.

Keep the proof agitated all the while it remains immersed. The image almost immediately begins to clear, the olive tints pass to black, and the lights lose color but do not disappear. When the dark parts are perfectly clear, and all the details of the negative well defined, remove the proof from the bath and wash it in five or six waters to remove all trace of acid. This washing must be conducted with the greatest care, as if any acid be left in the proof, it causes a precipitate of sulphur when it is placed in the hyposulphite of soda. To avoid this it is better to mix a little ammonia with the first wash water employed; washing in two waters after this will be sufficient. After it is washed, place the proof in a bath of hyposulphite of soda, containing 1 part of the salt to 6 of water. The proof must not be left in the bath less than half an hour, and may remain there for three or four hours without any of the details being destroyed; the precise tint being determined by the length of time the proof remains in the hyposulphite. The fixing is finished in the usual way by repeated washing in water. By using a bath of hyposulphite, containing chloride of silver in solution, still richer tones are produced; but the proof should always be placed for a few minutes in a bath of fresh hyposulphite, before being finally washed.

The addition of hydrochloric acid to the chloride of gold, precipi-

tates any silver which may remain in the proof, in the form of chloride, which cleans the whites of the picture; the chloride of silver being more easily dissolved by the hyposulphite, than any other salt.

A very beautiful neutral tint may be given to positives fixed in the ordinary manner, by immersing them for a few minutes in the following solution:—

Hyposulphite of Soda.....	2 oz.
Water	1 pint.
Nitrate of Silver	40 grs.
Chloride of Gold.....	6 grs.

Proofs of a bad colour may generally be rendered very beautiful by the use of this solution, they of course require to be well washed when removed from the bath.

In 1843, Sir J. Herschel described a process to which he gave the name of Chrysotype, which might be employed to produce either positives or negatives. As the paper requires a somewhat long exposure in the camera, it is more frequently employed for the former, and gives very beautiful results. The following details were published in the Philosophical Magazine for March, 1843:—

"Paper is to be washed with a moderately concentrated solution of ammonio-citrate of iron, and dried. The strength of the solution should be such as to dry into a good yellow colour, not at all brown.

"In this state it is ready to receive the photographic image, which may be impressed upon it either from nature in the camera obscura, or from an engraving on a frame in sunshine. The image so impressed, however, is very faint and sometimes hardly perceptible. The moment it is removed from the frame or camera, it must be washed over with a neutral solution of gold of such strength as to have about the color of sherry wine. Instantly the picture appears, not indeed at once of its full intensity, but darkening with great rapidity up to a certain point, depending on the strength of the solutions used, &c. As soon as the picture is satisfactorily brought out by the auriferous liquid, it is to be rinsed in water which is to be three times renewed, letting it remain in

the third water five or ten minutes. It is then to be blotted off and dried, after which it is to be washed on both sides with a somewhat weak solution of hydriodate of potash. If there be any free chloride of gold present in the pores of the paper, it will be discoloured, the lights passing to a ruddy brown, but they speedily whiten again spontaneously, or at all events on throwing it (after lying a minute or two) into fresh water, in which being again rinsed and dried, it is now perfectly fixed.

"If paper prepared as above directed be washed with nitrate of silver instead of solution of gold, a very sharp and beautiful picture is developed, of great intensity. Its disclosure is not instantaneous; a few moments elapse without apparent effect; the dark shades are then first touched in, and by degrees the details appear, but much more slowly than in the case of gold: in two or three minutes however the maximum of distinctness will not fail to be attained. The picture may be fixed by the hyposulphite of soda, which alone, I believe, can be fully depended on for fixing argentine photographs."

M. Le Gray, who has lately been experimenting with this paper, says that a little nitrate of silver added to the solution of ammonio-citrate of iron, increases the sensibility of the paper to such an extent, that it can be well used in the camera. He employs the following solution:—

Saturated Solution of Ammonio-citrate iron...	100	grammes.
Distilled Water	100	,,
Nitrate of Silver.....	2	,,

He says that the pictures may be developed not only with solutions of gold and silver, but also with gallic acid.

Very beautitul positives may be obtained on any of the unwaxed negative papers, and in dull weather better pictures can be obtained by this means, than on the ordinary positive paper. The time required for printing a proof on these papers is about one minute, or one minute and a half, by diffused daylight, and one or two seconds in sunshine.

POSITIVES ON GLASS

BY COLLODION, &c.

The collodion for the production of positives, should be somewhat thinner than that employed for negatives; 3 grs. of paper or cotton to the oz. of mixed alcohol and ether, and 4 grains of iodide of potassium, will generally be found sufficient. The production of a positive instead of a negative picture depends mainly on two circumstances, *viz*: the time of exposure in the camera, and the nature of the developing solution. Much less time is required to produce a positive than a negative, about one half the amount of exposure being sufficient.

To develop a positive, Mr. Horne recommended the addition of a little nitric acid to the pyro-gallic solution, but gave no proportion. I find that 1 drop of nitric acid to 2 drachms of the solution of pyro-gallic acid mentioned in a previous section, gives remarkably beautiful tints. A much longer time is required for the development; I have never known a good picture produced in less than five minutes, and it is often as much as twenty minutes before the development is complete. The fixing of the picture is performed in precisely the same way as that of a negative. When finished, the picture should be mounted with a black back ground; nothing is so good for this as a piece of thick cotton velvet. Some operators varnish the picture with Brunswick black instead of placing a black substance behind it; but this is very apt to shew through the white parts of the picture, and much impairs the effect.

Mr. Hennah gives the following formula for developing solution for positives.

	Protosulphate Iron	15 grs.
	Nitric Acid	1 or 2 drops.
	Distilled Water	1 oz.
Or,	Protosulphate Iron	20 grs.
	Acetic Acid	1 drachm.
	Nitric Acid	2 drops.
	Distilled Water	1 oz.

He says that with this solution, "soon after the picture begins to appear, and before the whole is visible, the developing solution must be poured off; it must be well washed with water, and fixed with the same solution of hyposulphite of soda as that used for negatives."

Dr. Diamond recommends a solution of proto-nitrate of iron prepared as follows:—

300 grains of nitrate of baryta are dissolved in 3 oz. of boiling distilled water. When the solution is complete, add 320 grs. of crystallized proto-sulphate of iron. When the white precipitate of sulphate of baryta has subsided, the clear solution of proto-nitrate of iron is poured off into a stoppered bottle for use. When this solution is to be used, it is mixed with a solution of

Pyrogallic Acid	3 grs.
Water	1 oz.
Acetic Acid	1 drachm.

in the proportion of 6 drops of the pyrogallic solution to 1 drachm of the proto-nitrate of iron. The solution of proto-nitrate of iron should be fresh made, as it will not keep for any length of time.

The production of positive pictures on collodion being so much more rapid than that of negatives, renders the process peculiarly adapted for taking moving objects. Mr. R. Hunt having lately stated that he did not think any process sufficiently rapid to obtain a representation of the waves of the sea, I may mention that I have seen pictures by Mr. W. Jackson of Lancaster, in which they were very perfectly represented. The process which he employs was published in a former edition of this work, and signed W. G. It consists in adding to each oz. of the ordinary iodized collodion, 1 gr. of arsenious acid; exciting with solution of nitrate of silver 100 grs. to the oz. of distilled water, to which some iodide of

potassium has been added to prevent its action on the plate; and developing with solution of proto-sulphate or proto-nitrate of iron 40 grs. to 1 oz. of distilled water. Warming the sensitive bath to about 100° F. still further increases the sensibility of the plate.

M. Martin has lately published a process for producing very powerful positives. The collodion is prepared and applied to the plate in the usual way; it is rendered sensitive by immersion in the following solution:—

Nitrate of Silver	365 grs.
Nitric Acid	218 grs.
Distilled Water	10 oz.

The image is developed in a bath of proto-sulphate of iron. When sufficiently developed it is well washed in water, and immersed in a bath consisting of

Cyanide of Potassium	386 grs.
Nitrate of Silver	62 grs.
Distilled Water	35 oz.

This bath almost immediately converts the negative into a positive. No farther fixing is required.

Very beautiful positives, especially for viewing as transparencies, or for use as slides to a magic lantern, may be produced on albumenized glass plates. Any of the preparations recommended for negatives on albumen may be employed, but the following preparation gives the best positives:

White of Egg	1 f. oz.
Distilled Water	¼ f. oz.
Saturated solution of Iodide of Potassium	10 drops,

the whole beaten into a froth, left to subside, and the clear liquor poured on the glass in the manner before described. The plates are excited with solution of nitrate of silver 25 grains to 1 oz, of distilled water, to every 8 parts of which, one part of glacial acetic acid has been added. The image is developed with saturated solution of gallic acid, and a few drops of solution of nitrate of silver. The picture is obtained by placing a negative on the prepared surface, and exposing to the light in the same manner as positives are printed on paper. Ten minutes will generally be found about the right time of exposure.

PROCESS FOR COPYING

MICROSCOPIC OBJECTS.

THE application of photography to the representation of microscopic objects has lately attracted a good deal of attention. I transcribe from the last number of The Microscopic Journal the directions given by Mr. J. DELVES, of Tonbridge, whose beautiful specimens have excited such general admiration.

"The only arrangement necessary for the purpose is the addition to the microscope of a dark chamber, similar to that of the camera obscura, having at one end an aperture for the insertion of the eye-piece end of the compound body, and at the other a groove for carrying the ground-glass plate.

"This dark chamber should not exceed 24 inches in length (the size which I have found best to adopt): if extended beyond this, the pencil of light transmitted by the object-glass is diffused over too large a surface, and a faint and unsatisfactory picture is the result. The eye-piece must be removed from the compound body, and the object (being well illuminated by reflection from the concave mirror) must be adjusted and focused upon the ground-glass plate.* In the production of positive pictures a slight difficulty here arises, dependent upon the "over-correction" of the object glass. The effect of this "over-correction" is to project the blue rays of light beyond the other rays of the spectrum, and as the chemical properties of light reside in the violet and blue rays, it becomes necessary that the plane of the sensitive plate should coincide with the foci of these rays, and it must therefore be placed beyond the surface at which the best definition is seen; this amounts to some distance with the lower combinations, and decreases with the increase of magnifying power.

"For the production of *negative* pictures, the ordinary illumination is not sufficient, and recourse must be had to the sunbeam, which should be reflected upon the object by the plane mirror when powers are used not exceeding the quarter of an inch combination. It is not necessary here (when producing negatives by the sun beam) to allow for the "over-correction" of the object-glass, but merely to focus the object carefully upon the ground-glass plate.

"In the production of negative pictures, a moment's exposure to the sunbeam is sufficient when using the lowest powers, and with the highest I have varied the time from five to ten seconds."

* The microscope must be placed in a perfectly horizontal position, in order to adapt it to the dark chamber.

An ordinary camera may be used for this purpose, the lens being removed and the eye-piece end of the microscope being introduced into the brass tube which carries it, the space between being filled up with a black silk handkerchief, or any convenient material which will exclude the light, and at the same time allow the tube of the microscope sufficient freedom for focusing. A tube of paper lined with black velvet or some other non-reflecting substance should be placed in the inside of the body of the microscope to prevent reflection from its sides. When using artificial light (a camphine lamp is best for the purpose), the mirror must be removed and a good condensing lens of about $2\frac{1}{2}$ inch diameter with its plane side next the lamp must be substituted, the precise position of this lens must of course depend on its focal length. The time of exposure necessary will vary with every object glass, and every object, and can only be determined by experiment.

STEREOSCOPIC PICTURES.

THE extremely beautiful effects produced by properly prepared photographs when viewed in the stereoscope, induce me to think that some directions for their production may not be unacceptable.

It is to Professor Wheatstone that we owe the invention of the stereoscope, and to his admirable papers on Binocular vision I must refer those who require a full account of the instrument and the interesting phenomena with which it is connected. I shall only here say enough of the instrument to enable the reader to understand the process for producing the pictures, and in doing this I shall avail myself as much as possible of Professor Wheatstone's own words. In the commencement of his paper, read before the Royal Society, June 12th, 1838, he says—

"When an object is viewed at so great a distance that the optic axes of both eyes are sensibly parallel when directed towards it, the perspective projections of it, seen by each eye separately, are similar, and the appearance to the two eyes is precisely the same as when the

object is seen by one eye only. There is in such case no difference between the visual appearance of an object in relief, and its perspective projection on a plane surface; and hence pictorial representations of distant objects, when those circumstances which would prevent or disturb the illusion are carefully excluded, may be rendered such perfect resemblances of the objects they are intended to represent as to be mistaken for them; the Diorama is an instance of this. But this similarity no longer exists when the object is placed so near the eyes that to view it the optic axes must converge; under these conditions a different perspective projection of it is seen by each eye, and these perspectives are more dissimilar as the convergence of the optic axes becomes greater. This fact may be easily verified by placing any figure of three dimensions, an outline cube, for instance, at a moderate distance before the eyes, and while the head is kept perfectly steady, viewing it with each eye successively while the other is closed. Fig. 6 represents the two perspective projections of a cube; *b* is that seen by the right eye, and *a* that presented to the left eye; the figure being supposed to be placed about seven inches immediately before the spectator.

"The appearances, which are by this simple experiment rendered so obvious, may be easily inferred from the established laws of perspective; for the same object in relief is, when viewed by a different eye, seen from two points of sight at a distance from each other equal to the line joining the two eyes. Yet they seem to have escaped the attention of every philosopher and artist who has treated of the subjects of vision and perspective. I can ascribe this inattention to a phænomenon leading to the important and curious consequences, which will form the subject of the present communication, only to this circumstance; that the results being contrary to a principle which was very generally maintained by optical writers, viz. that objects can be seen single only when their images fall on corresponding points of the two retinæ, an hypothesis which will be hereafter discussed; if the consideration ever arose in their minds, it was hastily discarded under the conviction, that if the pictures presented to the two eyes are under certain circumstances dissimilar, their differences must be so small that they need not be taken into account.

"It will now be obvious why it is impossible for the artist to give a faithful representation of any near solid object, that is, to produce a painting which shall not be distinguished in the mind from the object itself. When the painting and the object are seen with both eyes, in the case of the painting two *similar* pictures are projected on the retinæ, in the case of the solid object the pictures are *dissimilar*; there is therefore an essential difference between the impressions on the organs of sensation in the two cases, and consequently between the perceptions formed in the mind; the painting therefore cannot be confounded with the solid object.

"After looking over the works of many authors who might be expected to have made some remarks relating to this subject, I have been able to find but one, which is in the *Trattato della Pittura* of Leonardo da Vinci.* This great artist and ingenious philosopher observes, 'that a

* See also a Treatise of Painting, p. 178. London, 1721; and Dr. Smith's Complete System of Optics, vol. ii. p. 244, where the passage is quoted.

painting, though conducted with the greatest art, and finished to the last perfection, both with regard to its contours, its lights, its shadows, and its colours, can never show a relievo equal to that of the natural objects, unless these be viewed at a distance and with a single eye.' 'For,' says he, 'if an object C [fig 3] be viewed by a single eye at

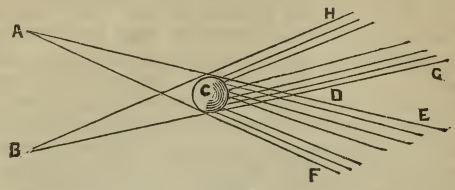


Fig. 3.

A, all objects in the space behind it, included as it were in a shadow ECF cast by a candle at A, are invisible to the eye at A; but when the other eye at B is opened, part of these objects become visible to it; those only being hid from both eyes that are included, as it were, in the double shadow CD, cast by two lights at A and B, and terminated in D, the angular space EDG beyond D being always visible to both eyes. And the hidden space CD is so much the shorter, as the object C is smaller and nearer to the eyes. Thus the object C seen with both eyes becomes, as it were, transparent, according to the usual definition of a transparent thing; namely, that which hides nothing beyond it. But this cannot happen when an object, whose breadth is bigger than that of the pupil, is viewed by a single eye. The truth of this observation is therefore evident, because a painted figure intercepts all the space behind its apparent place, so as to preclude the eyes from the sight of every part of the imaginary ground behind it.'

"Had Leonardo da Vinci taken, instead of a sphere, a less simple figure for the purpose of his illustration, a cube, for instance, he would not only have observed that the object obscured from each eye a different part of the more distant field of view, but the fact would also perhaps have forced itself upon his attention, that the object itself presented a different appearance to each eye. He failed to do this, and no subsequent writer within my knowledge has supplied the omission; that two obviously dissimilar pictures are projected on the two retinæ when a single object is viewed, while the optic axes converge, must therefore be regarded as a new fact in the theory of vision."

In a subsequent part of the same paper, Professor Wheatstone states "that if two perspective projections of the same solid, as it appears to each eye, be simultaneously presented to the eyes, instead of a representation on a plane surface, as each drawing appears to be when separately viewed by that eye which is directed towards it; the observer will perceive a figure of three dimensions the exact counterpart of the

object from which the drawings were made." He then proceeds to describe an instrument by which pictures may be thus presented to the eyes, to which he gave the name of stereoscope, to indicate its property of representing solid objects. The form of the instrument may be modified in various ways, but none is so good as that originally described, as it admits of the use of larger pictures, and of much greater adjustment to suit the sight of various persons, and the peculiarities of the pictures employed. I extract the description from the paper already referred to.

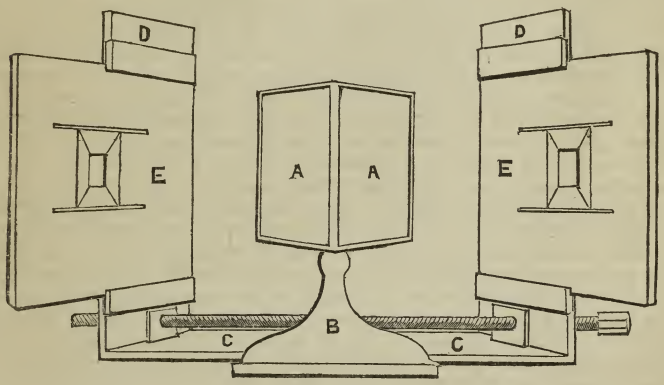


Fig. 4.

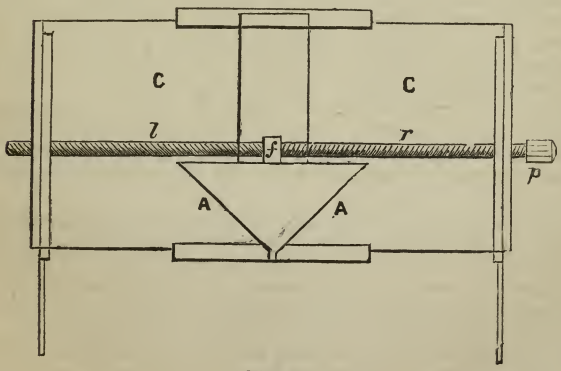


Fig. 5.

"The stereoscope is represented by figs. 4 and 5; the former being a front view, and the latter a plan of the instrument. AA′ are two plane mirrors, about four inches square, inserted in frames, and so adjusted that their backs form an angle of 90° with each other; these mirrors are fixed by their common edge against an upright B, or which was less easy to represent in the drawing, against the middle line of a vertical board, cut away in such manner as to allow the eyes to be placed before two mirrors. C C′ are two sliding boards, to which are attached the upright boards D D′, which may thus be removed to different distances from the mirrors. In most of the experiments hereafter to be detailed, it is necessary that each upright board shall be at the same distance from the mirror which is opposite to it. To facilitate this double adjustment, I employ a right and a left-handed wooden screw, *r l*; the two ends of this compound screw pass through the nuts *e e′*, which are fixed to the lower parts of the upright boards D D′, so that by turning the screw pin *p* one way the two boards will approach, and by turning it the other they will recede from each other, one always preserving the same distance as the other from the middle line *f*. E E′ are pannels, to which the pictures are fixed in such manner that their corresponding horizontal lines shall be on the same level; these pannels are capable of sliding backwards and forwards in grooves on the upright boards D D′. The apparatus having been described, it now remains to explain the manner of using it. The observer must place his eyes as near as possible to the mirrors, the right eye before the right-hand mirror, and the left eye before the left-hand mirror, and he must move the sliding pannels E E′ to or from him until the two reflected images coincide at the intersection of the optic axes, and form an image of the same apparent magnitude as each of the component pictures. The pictures will indeed coincide when the sliding pannels are in a variety of different positions, and consequently when viewed under different inclinations of the optic axes; but there is only one position in which the binocular image will be immediately seen single, of its proper magnitude, and without fatigue to the eyes, because in this position only the ordinary relations between the magnitude of the pictures on the retinæ, the inclination of the optic axes, and the adaptation of the eye to distinct vision at different distances are preserved. In all the experiments detailed in the present memoir, I shall suppose these relations to remain undisturbed, and the optic axes to converge about six or eight inches before the eyes.

"If the pictures are all drawn to be seen with the same inclination of the optic axes, the apparatus may be simplified by omitting the screw *r l* and fixing the upright boards D D′ at the proper distances. The sliding pannels may also be dispensed with, and the drawings themselves be made to slide in the grooves.

"A few pairs of outline figures, calculated to give rise to the perception of objects of three dimensions when placed in the stereoscope in the manner described, are represented in figs. 6 to 8. As the drawings are reversed by reflection in the mirrors, I will suppose these figures to be the reflected images to which the eyes are directed in the apparatus; those marked *b* being seen by the right eye, and those marked *a* by the left eye. The drawings, it has been already explained, are two different projections of the same object seen from two points of sight, the distance

between which is equal to the interval between the eyes of the observer; this interval is generally about $2\frac{1}{2}$ inches.

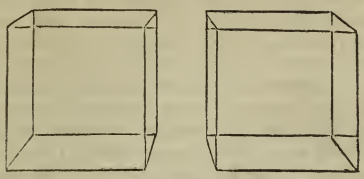


Fig. 6.

Fig. 6. A cube.

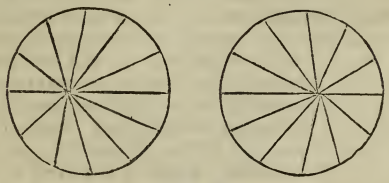


Fig. 7.

Fig. 7. A cone, having its axis perpendicular to the referent plane and its vertex towards the observer.

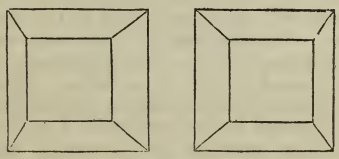


Fig. 8.

Fig 8. The frustum of a square pyramid; its axis perpendicular to the referent plane, and its base furthest from the eye.

"For the purposes of illustration I have employed only outline figures, for had either shading or colouring been introduced, it might be supposed that the effect was wholly or in part due to these circumstances, whereas by leaving them out of consideration no room is left to doubt that the entire effect of relief is owing to the simultaneous perception of the two monocular projections, one on each retina. But if it be required to obtain the most faithful resemblances of real objects, shadowing and colouring may properly be employed to heighten the effects. Careful attention would enable an artist to draw and paint the two compotent pictures, so as to present to the mind of the observer, in the resultant perception, perfect identity with the object represented. Flowers, crystals, busts, vases, instruments of various kinds, &c., might thus be represented so as not to be distinguished by sight from the real objects themselves.

"The preceding experiments render it evident that there is an essential difference in the appearance of objects when seen with two eyes, and when only one eye is employed, and that the most vivid belief of the

solidity of an object of three dimensions arises from two different perspective projections of it being simultaneously presented to the mind. How happens it then, it may be asked, that persons who see with only one eye form correct notions of solid objects, and never mistake them for pictures? and how happens it also, that a person having the perfect use of both eyes, perceives no difference in objects around him when he shuts one of them? To explain these apparent difficulties, it must be kept in mind, that although the simultaneous vision of two dissimilar pictures suggests the relief of objects in the most vivid manner, yet there are other signs which suggest the same ideas to the mind, which, though more ambiguous than the former, become less liable to lead the judgment astray in proportion to the extent of our previous experience. The vividness of relief arising from the projection of two dissimilar pictures, one on each retina, becomes less and less as the object is seen at a greater distance before the eyes, and entirely ceases when it is so distant that the optic axes are parallel while regarding it. We see with both eyes all objects beyond this distance precisely as we see near objects with a single eye; for the pictures on the two retinæ are then exactly similar, and the mind appreciates no difference whether two identical pictures fall on corresponding parts of the two retinæ, or whether one eye is impressed with only one of these pictures. A person deprived of the sight of one eye sees therefore all external objects near and remote, as a person with both eyes sees remote objects only, but that vivid effect arising from the binocular vision of near objects is not perceived by the former; to supply this deficiency he has recourse unconsciously to other means of acquiring more accurate information. The motion of the head is the principal means he employs. That the required knowledge may be thus obtained will be evident from the following considerations. The mind associates with the idea of a solid object every different projection of it which experience has hitherto afforded; a single projection may be ambiguous, from its being also one of the projections of a picture, or of a different solid object; but when different projections of the same object are successively presented, they cannot all belong to another object, and the form to which they belong is completely characterized. While the object remains fixed, at every movement of the head it is viewed from a different point of sight, and the picture on the retina consequently continually changes.

"Every one must be aware how greatly the perspective effect of a picture is enhanced by looking at it with only one eye, especially when a tube is employed to exclude the vision of adjacent objects, whose presence might disturb the illusion. Seen under such circumstances from the proper point of sight, the picture projects the same lines, shades and colours on the retina, as the more distant scene which it represents would do were it substituted for it. The appearance which would make us certain that it is a picture is excluded from the sight, and the imagination has room to be active. Several of the older writers erroneously attributed this apparent superiority of monocular vision to the concentration of the visual power in a single eye.*

* "We see more exquisitely with one eye shut than with both, because the vital spirits thus unite themselves the more, and become the stronger: for we may find by looking in a glass whilst we shut one eye, that the pupil of the other dilates."—Lord Bacon's Works, *Sylva, Sylvarum*, art. Vision.

"There are some facts intimately connnected with the subject of the present article which have already been frequently observed. I allude to the experiments, first made by Du Tour, in which two different colours are presented to corresponding parts of the two retinæ. If a blue disc be presented to the right eye and a yellow disc to the corresponding part of the left eye, instead of a green disc which would appear if these two colours had mingled before their arrival at a single eye, the mind will perceive the two colours distinctly, one or the other alternately predominating either partially or wholly over the disc. In the same manner the mind perceives no trace of violet when red is presented to one eye and blue to the other, nor any vestage of orange when red and yellow are separately presented in a similar manner. These experiments may be conveniently repeated by placing the coloured discs in the stereoscope, but they have been most usually made by looking at a white object through differently coloured glasses, one applied to each eye."

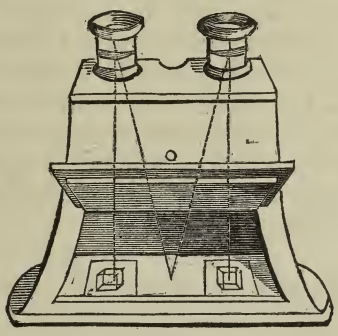


Fig 9.

Fig. 9 represents another form of the stereoscope in which the observer looks directly at the drawings instead of at their reflected images; the two being made to coalesce by the introduction of two prisms or semi-lenses into the eye-pieces of the instrument. This form possesses the advantages of cheapness and portability, but can only be used with small drawings, and does not admit of the same amount of adjustment as the reflecting stereoscope.

It is obvious that to make two pictures of any but the most simple objects with sufficient accuracy to be viewed in the stereoscope, would be extremely difficult, if not impossible; but as cameras can be placed in any position we please with regard to the object to be represented, photography supplies the means of producing stereoscopic drawings in the greatest perfection.

It is better if possible, to employ two cameras, and take the two

pictures simultaneously; as, even if the object to be copied remains perfectly fixed, the light may slightly change, and thus the position of some of the shadows be altered.

For near objects, such as portraits &c., the following is the best method of proceeding :—Describe a circle on the ground, and draw from its centre two radii, which shall form an angle of about 6° with one another. The object to be copied is placed on the centre of the circle, and the cameras at precisely equal distances from it and in the direction of the radii. Great care must be taken that the images in the two cameras are of precisely the same size, and that the same point of the object occurs precisely in the centre of each picture. To ascertain if this be the case, divide the ground glass of the cameras by pencil lines into a number of squares of about a quarter inch in size, and draw diagonal lines across the glass so as to mark its centre; by now observing how many of the squares are occupied by the object to be copied, and precisely the spot which coincides with the centre point on the ground glass, and shifting the cameras slightly until the two images perfectly agree in these respects, two pictures adapted for the stereoscope may be obtained.

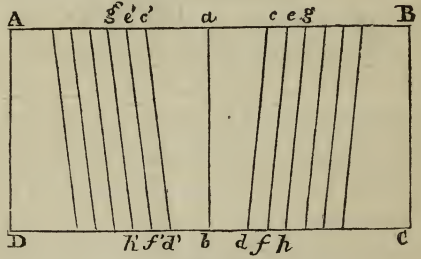


Fig 10

To avoid the trouble of drawing the lines on which to place the cameras every time they are wanted, the stand may be marked with a number of lines shewing the positions of the cameras for objects at different distances; the figure 10 will serve to explain this :—Let A B C D be the board on which the cameras stand, which we will suppose to be exactly 1ft. wide, and of any required length; the line *a b* divides it in the middle; the lines *c d* and *c' d'* represent the positions of the camera for an ob-

ject at 4 ft. distance from the point *b*; the points *c* and *c'* being respectively 3.4 in. from the point *a*, and the points *d* and *d'* 2.5 in. from the point *b*. The other lines répresent the positions of the cameras for objects at a greater distance, the distance between the lines increasing 1.25 in. for every 2 ft. that the point *b* is removed from the object to be copied. For distant objects, such as buildings &c., the operation is still easier, the cameras not requiring to be placed at an angle, but simply removed to a distance from one another varying with that of the object to be copied. Professor Wheatstone has determined that the cameras should be placed parallel to one another, and that the distance between them should increase two feet for every fifty feet that we recede from the nearest object in the landscape. To understand these arrangements, it must be borne in mind that the pictures are not intended to represent the objects as actually seen, but as they would be seen if reduced to the same size as the pictures, and placed at the same distance from the eyes. I cannot too strongly recommend amateurs of photography to turn their attention to this part of the subject. Many a perishable object of great beauty or interest, of which no accurate idea could be conveyed by the finest drawing, may be thus preserved and examined as perfectly as if the object itself were always at hand.

In conclusion, I would impress upon all who wish successfully to practice the art of Photography, the necessity of always employing *pure* chemicals and not allowing themselves to be led away by the apparent cheapness of inferior articles, as a single impurity is often enough to spoil what would otherwise be a good result. Another circumstance to which too much attention cannot be paid is, the necessity of extreme cleanliness; never take it for granted that any thing is clean unless you have yourself cleaned it, and remember that what is clean to other people must often be considered dirty by the photographer.

EQUIVALENT WEIGHTS

OF THE SUBSTANCES MOST COMMONLY EMPLOYED IN PHOTOGRAPHY

ELEMENTARY.

Barium	68	*Iron*	28
Bromine	78	*Oxygen*	8
Chlorine	36	*Potassium*	39
Gold	98	*Silver*	108
Hydrogen	1	*Sodium*	23
Iodine	126		

COMPOUND.

Acid Acetic	60	*Potassium Bromide*	117
„ *Hydrochloric*	37	„ *Cyanide*	65
„ *Nitric*	54	„ *Fluoride*	57
„ *Sulphuric*	40	„ *Iodide*	165
Ammonia	17	*Silver Bromide*	186
Ammonium Chloride	53	„ *Chloride*	134
„ *Iodide*	143	„ *Cyanide*	144
Barium Chloride	104	„ *Iodide*	234
Baryta Nitrate	130	„ *Nitrate*	170
Gold Chloride	304	*Sodium Chloride*	59
Iron Nitrate	90	*Soda Carbonate*	53
„ *Sulphate (cryst.)*	139	„ *Hyposulphite*	79

COMPARATIVE TABLE OF ENGLISH AND FRENCH WEIGHTS AND MEASURES.

	GRAINS.
1 *Pound Avoirdupoise* . . .	7000
1 *Ounce ditto*	437.5
1 *Pound Troy*	5760
1 *Ounce ditto*	480

Gramme	15.432
Decigramme	1.5432
Centigramme	0.15432
Milligramme	0.015432

	INCHES.
Yard	36
Metre	39.37079
Decimetre	3.93708
Centimetre	0.39370
Millimetre	0.03937

	CUBIC INCHES.	GRAINS OF DISTILLED WATER
Imperial Gallon .	277.274 .	70000
Ditto Pint .	34.65925 .	8750
Ditto Ounce .	1.7329625 .	437.5
Cubic Inch . .	1. .	252.458
Litre . . .	61.02525 .	15432.
Decilitre . .	6.10252 .	1543.2

TABLE OF CONTENTS.

CATALOGUE

OF

PHOTOGRAPHIC APPARATUS,

Chemical Preparations & Materials,

MANUFACTURED AND SOLD BY

RICHD. WILLATS,

(LATE T. & R. WILLATS,)

OPTICIAN AND PHILOSOPHICAL INSTRUMENT MAKER,

28, IRONMONGER LANE,

(REMOVED FROM 98, CHEAPSIDE,)

LONDON.

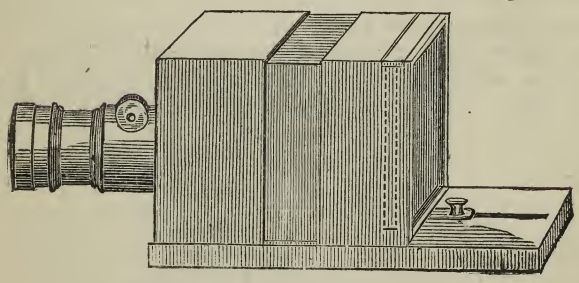


Fig. 1.

	£	s.	d.
Improved Shifting Back Camera, with Achromatic lens, 3 in. in diameter, mounted in brass sliding tube, with diaphragms to take pictures 10 by 8in. . fig. 1.	10	10	0
Ditto ditto with rackwork adjustment and double slide, Fig. 2, to hold two prepared papers .	£11	10 &	12 0 0

	£	s.	d.
Ditto ditto with Achromatic lens, sliding adjustment to take pictures 6 by 7 in. . . . £5 &	6	0	0
Ditto ditto with Achromatic lens to take pictures 5 by 4 in.	2	10	0

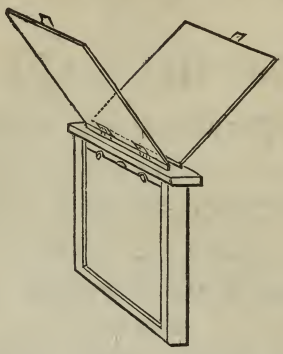


Fig. 2.

Improved Shifting Back Camera, with best double combination Achromatic lenses and diaphragms, to take Pictures $8\frac{1}{2}$ by $6\frac{1}{2}$ in. . . £14 14s. &	18	18	0
Ditto ditto to take $6\frac{1}{2}$ by $4\frac{3}{4}$ in. . 10 10 &	12	12	0
Ditto ditto to take pictures 4 by 3 in. . . .	5	15	0
Photographic Camera, with brass sliding front and miniscus lens for obtaining pictures on paper, 4 by 4 in. .	1	1	0
Ditto ditto with brass sliding front and Achromatic lens	1	5	6

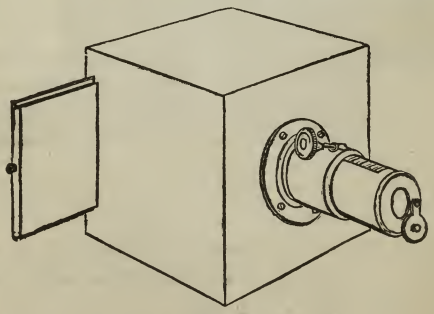


Fig. 3.

Photographic Camera, with rackwork adjustment and Achromatic lens fig. 3 . . from £1 15s., to	2	2	0

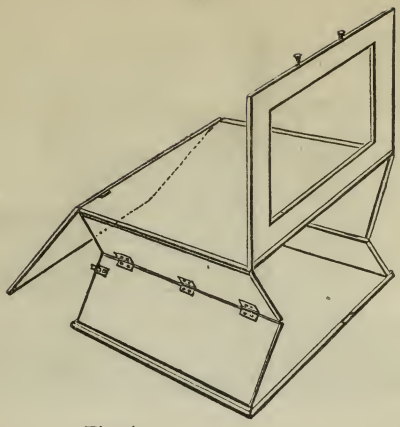


Fig 4.

	£	s.	d.
Folding Cameras with single Achromatic lens fig 4 from	5	5	0
Folding Camera of the best make, with Achromatic lens in rackwork front, with double paper holder and 1 holder for glass plates, to take pictures 10 by 8 in., perfect to the edges	16	16	0
Ditto ditto made to order, to suit lenses of various focal lengths.			

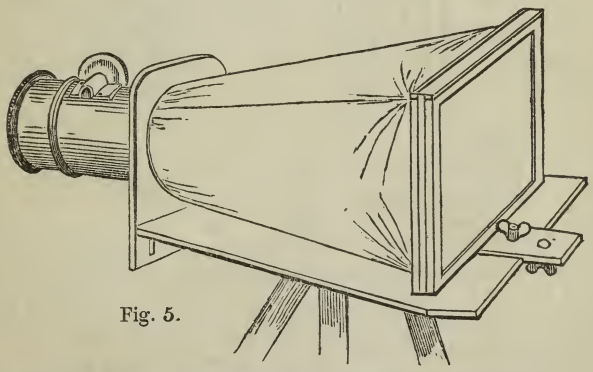


Fig. 5.

R. Willats' Portable Camera with flexible cloth body, angular, vertical, and horizontal adjustments, with Achromatic lens and rackwork front to take pictures, 10½ by 8 in. fig. 5.	11	11	0
Ditto ditto with angular adjustment and sliding tube .	9	9	0

This form of Camera, shown at the Exhibition of 1851, is so constructed as to admit of being packed into a very small space and extremely convenient for Travellers being easily carried and not liable to derangement.

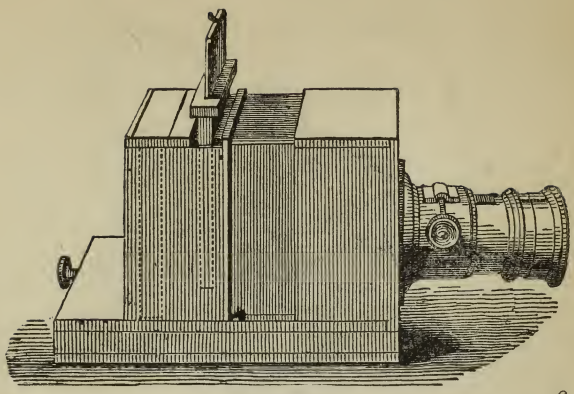


Fig. 6.

		£	s.	d.
* Willats' Improved Camera with double Achromatic combination lenses, to take pictures 4 by 3, adapted for portraits, with screw adjustment . . fig. 6.		6	0	0

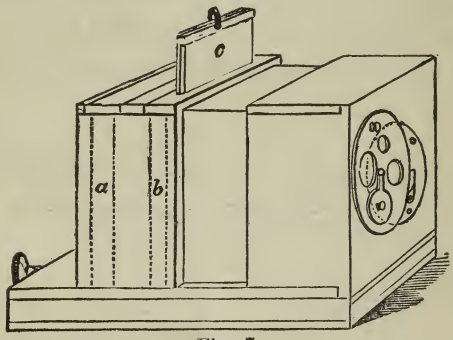


Fig. 7.

* Willats' Improved Camera, with single achromatic lens and revolving diaphragm to take pictures 4 by 3, $3\frac{1}{4}$ by $2\frac{3}{4}$, and $2\frac{1}{2}$ by 2 in. . . . fig. 7		3	10	0
Cundell's Camera with double combination of miniscus lenses, to take a picture, $7\frac{1}{4}$ by $6\frac{1}{4}$ in., as described in the "Philosophical Magazine" . . .		5	5	0
A pair of Cameras with double combination Achromatic lenses, arranged for taking Stereoscopic Portraits, $2\frac{1}{2}$ by 2, $3\frac{1}{4}$ by $2\frac{3}{4}$, and 4 by 3 in.		12	0	0
Microscopic Copying Cameras made to suit Table Microscope.				

* These forms of Camera are well adapted for taking portraits by the collodion process.

	£	s.	d.
Complete set of Apparatus and Chemicals to take Collodion Pictures on glass, in a case . . from	3	3	0
Complete set of Photographic Apparatus, including Chemicals, &c., for Paper Process, in case, to take pictures 4 by 4 in. . . . . from	3	3	0
Ditto ditto in stout packing case with lock and key to take pictures 5 by 4 in.	5	5	0
Ditto ditto ditto, with extra dark slide for collodion process, Chemicals and Apparatus . . .	6	6	0
Ditto ditto, with double dark paper slide, Chemicals &c., in case, with lock and key, to take 6 by 7 in. . .	10	10	0
Ditto ditto ditto with dark slide for collodion process, Chemicals and Apparatus complete, to take $6\frac{1}{2}$ by $7\frac{1}{2}$ in. .	13	0	0

Larger sets fitted up to order.

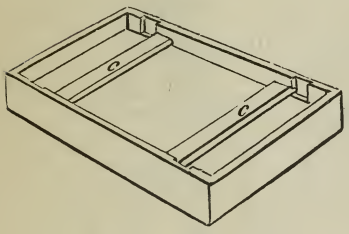


Fig. 8.

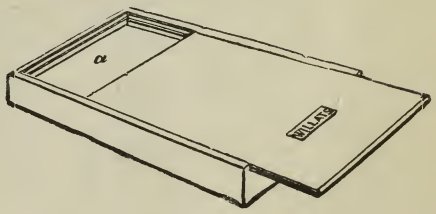


Fig 9.

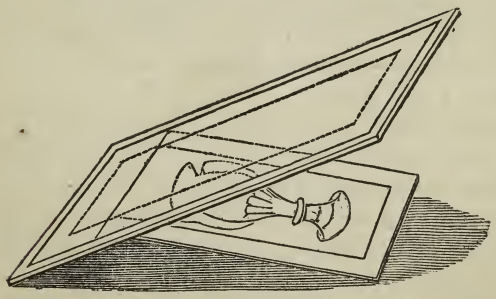


Fig. 10.

Copying frames and glass for obtaining positive photographs with padded backboard and pressure bars, fig. 8, 5/6 & 0 7 6

	£	s.	d.
Copying Frame, with sliding lid for ditto . fig. 9.	0	10	6
Johnstone's Improved ditto, with hinged back, so that the progress of the process can be conveniently viewed without disturbing the papers . fig. 10, from	0	16	0
Very strong pressure frames with screws at back . from	0	16	0

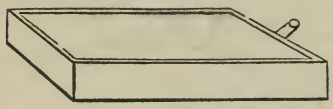


Fig. 11.

Fig. 12.

Tin vessels for heating photographic drawings . fig. 11.	0	5	0
Photographic Etnas . . . fig. 12, each	0	5	6
Flat Porcelain Pans for washing and setting pictures 1s. 6s. &	0	2	6
Large ditto, 12 by 10 inches	0	4	6
Extra ditto ditto	0	7	6
Polished Glass Dishes for ditto ditto . . from	0	14	0
Gutta Percha Dishes in sets of 4 . . .	1	5	0
Gutta Percha Dipping Baths for collodion process, fig. 2, p. 39, Larger Sizes to Order. 3s., 4s. 6d. &	0	6	6
Glass Dipper for above . . .	0	1	0
Flat Glass Baths . . . . from	0	5	0
Air Pumps and Exhausting Syringes various . .			
Stewart's Apparatus for preparing paper . . .			

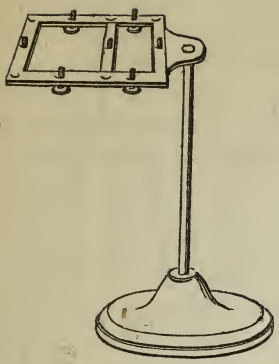


Fig. 13.

Fig. 14.

		£	*s.*	*d.*
Tripod Stands, or levelling stands . .	fig. 14	0	5	6
Best ditto ditto	fig. 13	0	10	6

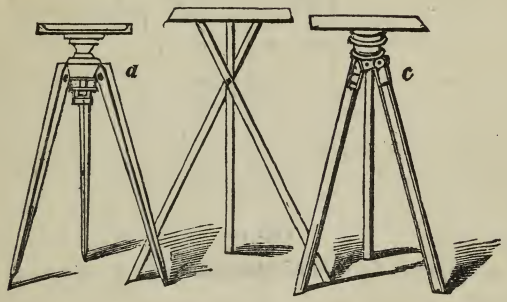


Fig. 15

Camera Stands, French Polished Mahogany	fig. 15, *a*	1	16	0
Ditto ditto, jointed legs ditto . .	.	2	2	0
Common ditto ditto, with ring top . .	from	0	16	0
Portable ditto ditto .	fig. 16. 21s., &	1	10	0
Ditto ditto, fig. 17, very firm . .	from	1	15	0
R. Willats' Improved Ball and Socket Tripod Camera Stand, very portable, and by a new and simple arrangement of the screw & wedge, the ball can be firmly clamped, capable of holding a heavy camera without liability of shifting		2	10	0

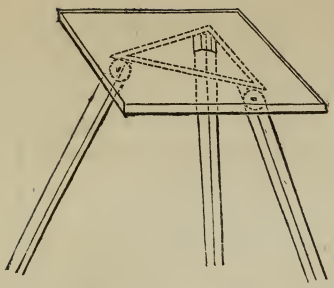


Fig. 16.

Fig. 17.

	£	s.	d.
Head Rests, best portable	0	7	6
Willats' Improved Johnstone's Head Rest . .	1	10	0

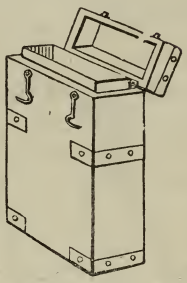


Fig. 18.

Boxes of various sizes for holding glass plates, price according to finish.

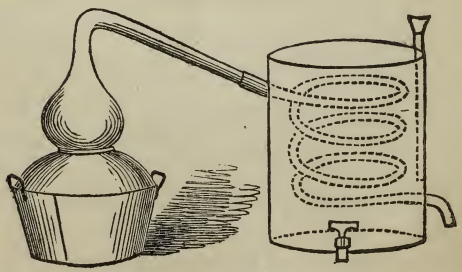


Fig. 19.

	£	s.	d.
Portable Still, with worm and tub for the distillation of water on common fire . . fig. 19, 1 gallon	1	1	0
Ditto ditto, best make	1	5	0
Ditto ditto, best make . . . 2 gallons	2	0	0
Improved Camel's Hair Brushes prepared expressly for Photographic purposes . . . round	0	1	0
Ditto ditto . . . . flat	0	1	6
Ditto ditto larger sizes . . 2s. 6d. &	0	3	6
Glass tube with silver wire for Buckle's cotton wool brush .	0	2	6
Velvet Buffs for polishing glass plates . each 1/10 &	0	3	6
Turner's superior Paper, made expressly for Photographic purposes . . . . per quire	0	4	0
Ditto ditto . . . . quarto	0	2	0
Whatman's (selected) . . per quire folio	0	5	0
Ditto ditto . . . . quarto	0	2	0
Cansons Fréres' negative paper, best make per quire	0	3	0
Ditto ditto positive	0	4	6
Papier Joseph			
Waxed Paper to order			
Stout White Wove Blotting Paper . . .	0	1	6
Pink ditto ditto	0	1	6
Patent Glass Plates, $3\frac{1}{4}$ by $2\frac{3}{4}$ . . per doz.	0	1	6
„ 4 by 3 . . „	0	2	0
„ $4\frac{1}{4}$ by $3\frac{1}{4}$ . . „	0	2	6
„ 5 by 4 . . „	0	3	6
Larger sizes cut to order.			
Best selected Glass Plates of the above sizes will be rather higher in price.			
Plate Glass Slabs of various sizes . 1s., 2s., 3s. &	0	5	0
Glass Spirit Lamps . . . 2s. 6d., 3s. 6d. &	0	5	0
Shallow Glass Troughs of various sizes . . .			
Glass Tubes for Reeves' Albumen Process . .	0	0	6
Steaming Apparatus for ditto ditto, made to order .			
Porcelain Evaporating Dishes . . . 9d. &	0	1	0
Finest Cotton Wool for Brushes . . per oz.	0	0	3
Silver Leaf . . . . per book	0	1	6
Mastic Varnish . . . per bottle	0	1	0

	£	s.	d.
Thermometers, Warranted . . from	0	2	6
Retort and Receiver Stands, glass retorts, receivers and flasks, &c.			
Glass Funnels and Stirring Rods . . .			
Glass Triangle for pressing down paper in solutions .			
Graduated Glass Measures . . . 1s. 4d. &	0	1	6
Mortars and Pestles			
Pipettes . . . . . 6d. &	0	0	8
Scales and Weights, common	0	3	6
Ditto ditto, glass pans, best, ...	0	18	0
Tin Plate for waxing proof . . . 6d. &	0	1	0
Glass stoppered Bottles for holding chemical preparations of various sizes . . from each	0	0	6
Yellow glass stoppered bottles of various sizes.			

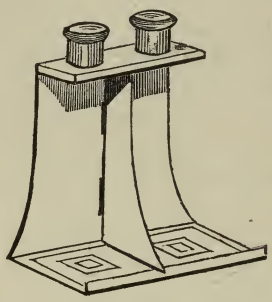


Fig. 20.

Wheatstone's Reflecting Stereoscope, fig. 4, page 65 .			
Ditto Refracting ditto, with diagrams, fig. 9, page 69 15s. &	1	1	0
Japanned tin ditto, with diagrams . . fig. 20	0	5	0
Photographic Views in variety . from each	0	4	6
Ditto ditto, for Stereoscope . „	0	3	0
Collodion Views for ditto . . „	0	10	6
Daguerreotype Views for ditto . . „	0	6	6
Passe Partout, or Skeleton Frames, for mounting Photographs, in variety . . each, from	0	0	6
Morocco Leather Cases, lined with Velvet, gilt Mats and best Glass for Portraits; according to size.			

Pure Chemicals,

FOR PHOTOGRAPHIC PROCESSES ON PAPER OR GLASS.

		£	s.	d.
Acid Acetic, crystalisable	per oz.	0	1	0
—— ——— ordinary	,,	0	0	8
—— Gallic, pure	,,	0	5	0
—— Hydrochloric, pure	,,	0	0	2
—— Nitric, pure	,,	0	0	3
—— Nitro-Muriatic	,,	0	0	4
—— Pyro-Gallic	per dram	0	4	0
—— Succinic, pure	per oz.	0	5	0
—— Sulphuric, pure	,,	0	0	2
Ammonia Solution	per oz., 2d. &	0	0	3
——— Hydrochlorate, pure		0	0	6
Copper Sulphate	per oz.	0	0	3
Collodion	,,	0	1	0
* Willats' prepared Collodion	,,	0	1	0
Archer's ditto ditto		0	0	9
Arsenicated ditto		0	1	0
Rectified Sulphuric Ether		0	1	0
Acetate of Lead	per oz.	0	0	3
——- of Lime	,,	0	0	6
Baryta Hydrochlorate, pure	,,	0	0	6
——— Nitrate, pure	,,	0	0	6
Salt of Gold or Sel D'or	per bott.	0	5	0
Iron Ammonio Citrate	per oz.	0	1	0
—— Sulphate, pure		0	0	2
—— Proto Nitrate Solution				
Iodine, pure resublimed		0	3	0
Syrup of the Iodide Iron		0	1	6
Lime Chloride, pure	,,	0	0	6
Potassium Bromide, pure		0	5	0
——— Ferro Cyanuret, Pure	,,	0	0	6
——— Ferro Sesquicyanuret	,,	0	2	6
——— Fluoride	,,			

* This, if required for export, can be had with Iodizing preparation separate.

		£	s.	d.
Potassium Cyanide . . .	„	0	1	0
——— ——— Pure . . .	„	0	3	6
——— Iodide, Pure . . .	„	0	3	0
——— Nitrate, pure . . .	„	0	0	3
Silver Nitrate Pure, crystalised . .	„	0	5	6
—— Potassio Cyan. Silver Solution . .	„	0	1	6
—— Oxide	„	0	8	0
Silver Ammonio Nitrate Solution . .	„	0	1	0
Soda Hyposulphite	per lb.	0	3	0
—— ———	per oz.	0	0	3
Sodium Chloride, pure . . .	.	0	0	6
Perfectly pure Animal Charcoal . .	per oz.	0	0	8
Virgin Wax	„	0	0	4
Finest Tripoli	.	0	0	6
Distilled Water	per gall.	0	1	0
Pure Gelatine	.	0	0	6
Sugar of Milk	.	0	0	6
Pale Laquer	per bott.	0	1	0
Willats' Preparation for making Iodized Paper by one application or wash	per bott.	0	2	6

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